Use and Evaluation of the Nutrient Density Concept for Assessing the Impact of Socioeconomic Factors on Nutritional Quality of Diets

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USE AND EVALUATION OF THE NUTRIENT DENSITY CONCEPT FOR ASSESSING THE IMPACT OF SOCIOECONOMIC FACTORS ON NUTRITIONAL QUALITY OF DIETS

by

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Carol Thompson Windham

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ABSTRACT

Use and Evaluation of the Nutrient Density Concept
for Assessing the Impact of Socioeconomic Factors
on Nutritional Quality of Diets

by

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Data from 7285 individual participants in the USDA Spring Nationwide Food Consumption Survey were analyzed using the nutrient density concept and multiple regression procedures to evaluate the impact of socioeconomic status on the nutritional quality of foods consumed. For each socioeconomic group the average daily amount of nutrients consumed per 1000 kcal of food consumed were computed and compared with the Recommended Dietary Allowances which had been converted to single-value nutrient allowances per 1000 kcal. This nutrient density approach identified qualitative patterns of food consumption for selected income, region, urbanization, household size, race, employment and education groups as well as indicating the degree to which these groups met the RDA.

Results demonstrated that socioeconomic status had relatively little impact upon the average nutrient density of diets consumed by the population. Income level had no statistically significant effect upon the nutritional quality of diets for any of the fourteen nutrients studied. Household size affected nutrient density

consumption of fat, carbohydrate, vitamin B_6 and vitamin C. Race affected calcium, magnesium, vitamin A and thiamin density of diets. Other socioeconomic factors were significantly related to only one or two nutrients. The differences in average nutrient density of diets resulted from differences in the quality of foods consumed from the Basic Four (nutrient-dense) Plus One (calorie-dense) food groups and not from differences in the percent contribution of these two food groups to nutrient intake per 1000 kcal.

Average diets for all socioeconomic groups were below nutrient density standards for calcium, iron, magnesium, vitamin B_6 and carbohydrate. There was also a high frequency of individuals with vitamins A and vitamin C intakes below nutrient density standards despite adequate group mean intakes per 1000 kcal for these nutrients.

Results supported the hypothesis that, regardless of socioeconomic status, Americans consume diets that average very similar nutrient content per energy unit. This type of information contributes to a better understanding of dietary habits of Americans and provides a meaningful framework from which to establish guidelines for government agencies, nutrition educators and the food industry.

(193 pages)

STATEMENT OF THESIS PROBLEM

Introduction

Issues related to nutrition and food consumption involve complex interactions among social, economic, cultural and physiological factors. A great deal of research effort has been directed toward analysis of the impact of these factors upon daily food choices and nutrient intakes of individuals in the United States. Few studies, however, have been designed to determine the effects of demographic and socioeconomic variables upon the nutrient density of diets. Evaluation of the nutrient density of food intake provides a means of examining and comparing the nutritional quality of diets consumed by various population groups. Nutrient density patterns may prove to be more meaningful than intake of individual foods or nutrients alone when determining relationships between nutrition and socioeconomic status.

Nature and Origin of the Study

Nutrient consumption research in the United States has focused upon determining estimates of average amounts of energy and nutrients consumed by various segments of the population. Major nutritional status and dietary surveys, such as the Ten State Nutrition Survey, 1968-1970 (USDHEW, 1972), the First Nationwide Health and Nutrition Examination Survey, 1971-1972 (USDHEW, 1973) and the Household Food Consumption Survey, 1965-1966 (USDA, 1969) have been conducted for the purpose of monitoring the nutritional status of the U.S. population.

Data from these surveys have been analyzed to assess the impact of income and other socioeconomic characteristics of individuals and households upon the consumption of food nutrients.

In the analysis of these surveys, dietary adequacy was evaluated by first determining estimates of average amounts of energy and nutrients consumed by selected population groups. These averages were then compared with appropriate Recommended Dietary Allowances published by the Food and Nutrition Board (1980a). Although specific findings varied among each of these surveys, certain general conclusions were common to all three studies. Specific groups within the population were identified as being malnourished or at "high-risk" of developing nutritional problems. These included low-income, less-well educated and minority groups, as well as specific age and sex groups. Socioeconomic status, racial origin, age and sex were reported to be significant factors affecting dietary adequacy and nutritional status.

Adequacy of individual diets can be influenced by the total amount of food consumed as well as by the nutritional quality of that food. Nutrient density, or the content of nutrient per energy unit of food consumed, is a measure of the nutritional quality of food relative to its calorie content. Determination of the nutrient density of foods provides an indication of the degree to which nutritional adequacy of diets is either a quantitative function of the total amount of food consumed or is dependent upon specific choices of foods with high nutrient content. Analysis of diets utilizing the nutrient density concept provides a means of determining the quality of diets being consumed by individuals or groups.

Results of the national nutritional status (USDHEW, 1972; 1973) and food consumption (USDA, 1969) surveys have included descriptions of the nutrient densities of diets of selected segments of the U.S. population. Researchers primarily utilized tabular analysis in which averages of nutrient intakes per 1000 kcal were compiled for various sex, age and socioeconomic groups. Little attempt was made to interpret the tabulated nutrient density values or to draw conclusions regarding nutritional quality of diets based upon these values.

One of the limitations to the analysis of nutrient density data has been the lack of dietary allowances, based upon nutrient density, which would serve as standards for evaluating nutritional quality. The utility of expressing nutrient allowances on a nutrient density basis was a principal issue at a recent European nutrition conference (Wretlind, 1977) although no general consensus was reached at this meeting. Nutrient allowances per 1000 kcal have been adopted for use in Sweden (Medical Expert Group, 1975) and the adoption of similar standards has been advocated by nutritionists in Great Britain (Passmore et al., 1979) and the United States (Hegsted, 1975; Hansen et al., 1978; Hansen and Wyse, 1980).

Currently in the U.S., distinctions are made between dietary allowances for males and females of different ages because of differences in growth rate or body weight and body composition (Food and Nutrition Board, 1980a). However, conversion of the table of Recommended Dietary Allowances into recommended levels per unit of energy illustrates that the variability in the recommendations per calorie is not very great, considering the reliability of estimated need (Hegsted, 1975).

Hansen and Wyse (1980) have recently demonstrated that allowances per 1000 kcal for many nutrients are constant or approximately constant across all sex-age categories. These authors have derived single-value nutrient allowances per 1000 kcal designed to meet the needs of all groups in the population when the energy needs of each group are met. For those nutrients whose recommended values per 1000 kcal are not constant for all sex-age classifications, the single-value allowances suggested as standards are based upon the needs of those individuals whose calorie requirements are least, since they find it most difficult to meet all dietary allowances.

Expressing dietary allowances and the nutritional composition of foods or diets on the same basis, i.e., nutrients per 1000 kcal, allows for a direct comparison between the two parameters from which quality judgments may be derived (Hansen et al., 1978). Diets can be examined and compared with respect to their ability to meet dietary allowances in terms of the calories provided.

Some authors (Hejda et al., 1977) contend that nutrient density standards are more appropriate for use in planning diets and food supplies than for the evaluation of food consumption records. However, appropriate methods for evaluating dietary data with current standards and the conclusions which may legitimately be drawn from such data, have not been clearly specified (Hegsted, 1975). The U.S. Department of Agriculture (USDA) has recognized that simpler and more reliable methods are needed for assessing nutritional status of population groups (USDA, 1979a). The USDA has included among its research priorities for the 1980s an objective to "improve nutritional status monitoring" in order to identify groups at high nutritional risk and to document changes in the nutritional status of the population at large. Nutrient density analysis warrants evaluation as a method for identifying relationships between demographic, social and economic characteristics of groups and the nutritional quality of their diets.

Nutrient density is also of interest when examining changes which have occurred in the levels of energy-yielding nutrients in the U.S. diet. Changes which appear to be of greatest concern at this time relate to fat and carbohydrate because they are being implicated, by research, with major health problems such as heart disease.

The fat content of the U.S. diet has increased about one-fourth over the past 65 years, accompanied by changes in the sources of fat (Page and Friend, 1978). A larger percentage of calories from fat now comes from unsaturated, rather than saturated, fatty acids. Changes in the level of carbohydrates have been in the opposite direction. Today, one-fourth less carbohydrate is present in the U.S. diet than during 1909-1913. The decrease in the starch component has been twice as great as the decline in total carbohydrate, while the level of sugars has increased one-fourth. As a result, sugars now account for the larger share of calories from carbohydrates.

Recently, the USDA and the Department of Health and Human Services (formerly Health, Education and Welfare) (USDA and USDHHS,

1980) issued dietary guidelines for Americans which emphasize moderation of dietary habits and limitation of certain food components. The recommended changes include lowering the proportion of calories coming from fats, reducing the level of saturated fats, changing the balance among fats and increasing the proportion of complex carbohydrates by substituting starches for fats and sugars.

In an attempt to help the public become more aware of levels of these nutrients in their diets, the USDA (1980a) has introduced a new food group. The four original groups, Fruit-Vegetables, Bread-Cereal, Milk-Cheese and Meat-Poultry-Fish-Beans, supply vitamins, minerals and protein as well as calories. The new fifth group, Fats-Sweets-Alcohol, provides mainly calories and little in the way of other nutrients.

In terms of nutrient density, foods in the original four groups are more "nutrient-dense" when compared with foods in the new group which are considered to be "calorie-dense." The nutritional contribution of foods from the Fats-Sweets-Alcohol group is more limited than that of the other four groups. However, very little is known about the effect of consumption of foods from this calorie-dense group upon the nutrient density of American diets. This type of information would add another dimension to the understanding of nutrient consumption patterns and the nutritional quality of foods in the United States.

Statement of the Problem

The diversity and complexity of demographic, economic and sociological factors affecting food consumption behavior make the study of nutrient intake difficult. Specification of the impact of various socioeconomic characteristics of the individual on daily nutrient consumption has provided insights into which population groups are most vulnerable to inadequate nutrient intakes. Alternative approaches to the analysis of food consumption survey data are needed in order to obtain a more comprehensive description and understanding of nutrient consumption patterns in the United States.

Purpose of the Study

The purpose of this study was to apply the nutrient density concept to the analysis of food consumption survey data. Nutrient density analysis was used to specify relationships between socioeconomic characteristics of population groups and the nutrient densities of their diets. The contribution of nutrient-dense and calorie-dense foods to the diets of these population groups was also determined. The effectiveness and appropriateness of the nutrient density approach for the analysis of food consumption data was evaluated.

Objectives of the Study

The objectives of this study were:

1. To estimate the effect of selected demographic and

socioeconomic factors on the nutrient densities of diets;

2. To determine similarities and differences in the nutrient densities of diets of selected population groups and to identify patterns which might exist;
3. To compare nutrient densities of diets with single-value nutrient allowances per 1000 kcal to obtain a measure of the nutritional quality of diets, i.e., the potential of foods consumed to meet nutritional needs;
4. To determine the contribution of nutrient-dense and calorie-dense foods to the diets of selected population groups;
5. To evaluate the utility of the nutrient density approach to the analysis of food consumption survey data and for providing meaningful information regarding nutrient consumption patterns;
6. To examine the policy implications of the findings relative to nutrition education, national nutrition guidelines and production and marketing decisions.

Significance of the Study

National nutritional surveillance is essential for maintaining and improving optional levels of nutrition in the United States. The analysis of food consumption survey data provides baseline information for a variety of endeavors aimed at achieving this end. These include the development of dietary guidance materials, nutrition education messages, food labeling and fortification policies and estimation of human nutrient requirements. For this reason it is important that available data be examined from a number of vantage points, utilizing a variety of methods, in order to obtain a comprehensive understanding of what the American public is eating. One significant result is that nutrition oriented programs can more realistically address important health issues by focusing on areas of nutritional concern identified in the survey data.

Research Design

The source of data for this study was the Spring Quarter of the Nationwide Food Consumption Survey, 1977-1978 conducted by the U.S. Department of Agriculture. This survey included 8661 individuals from a statistically selected sample of households in the forty-eight contiguous states. The data provided information on daily food and nutrient intake as well as on various demographic, socioeconomic and physiological characteristics of the participants.

In this study, the average daily amount of nutrients consumed per 1000 kcal of food consumed was computed from the nutritive value data previously compiled by the USDA. The nutrients evaluated were protein, carbohydrate, fat, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, preformed niacin, vitamin B_6, vitamin B_{12}, and vitamin C.

Multiple linear regression analysis was used in the data analysis to determine the effect of selected socioeconomic factors on nutrient density of diets. The dependent variables were the average daily amount of each nutrient consumed per 1000 kcal of food reported as consumed by individuals in the survey. The independent variables were those hypothesized to affect the nutrient density of diets, that is, geographic location and degree of urbanization of the place of residence, annual household income, household size, employment status and educational attainment of the male and female heads of households, and race or ethnic origin of individuals. Sex, age, height and weight of individuals were included in the analysis to control for variations in nutrient density intakes which might otherwise be attributable to differences within these factors. The significance of the effect of the factors on nutrient density was evaluated using appropriate statistical tests.

Comparisons were made of the mean nutrient consumption per 1000 kcal for subgroups of the population which were defined in terms of the independent variables. Means were adjusted to account for differing distributions of individuals within each subgroup. The average nutrient consumption per 1000 kcal for the groups were compared with single-value nutrient allowances per 1000 kcal to assess the nutritional quality of diets of the groups.

For each population group, the nutrient density of foods contributed by the Fat-Sweets-Alcohol food group were computed and compared with nutrient densities of foods contributed by the other four food groups.

Hypotheses

The nutrient density of diets consumed by various sociological, economic and demographic groups is similar, despite variations in food consumption patterns and practices. Utilization of the nutrient density concept to evaluate food consumption survey data is appropriate and useful for improving basic knowledge and understanding of nutrient consumption patterns of the total population and of population subgroups.

Limitations

National and regional surveys can be expensive in terms of time and financial resources; therefore, extensive use of available national and regional data to analyze relevant problems is imperative. Utilization of data which has been collected for other purposes can put limitations on the researcher. This study could have been enhanced by (1) inclusion of additional variables such as nutrition knowledge and attitude of the homemaker; (2) additional subcategories for some variables, e.g., the data provided only three categories of race; and (3) inclusion of data on additional nutrients of concern, such as zinc, folic acid and different types of fats. These data, however, were not available for this study.

Another limitation relates to difficulty of measuring the utility of the nutrient density concept for the analysis of food consumption survey data. Other than professional judgment, there are no objective or statistical criteria for evaluating this methodology. The procedure can be evaluated only in terms of its ability to produce meaningful and interpretable results.

Definition of Terms

Basic Four Plus One Food Groups: A food guide devised to translate the technical language of nutrients and recommended dietary allowances into terms of daily eating habits. Using this method, foods are categorized into four nutrient-dense and one calorie-dense groups based upon their similar nutrient content. The five groups include: 1) Fruit and Vegetable; 2) Bread and Cereal; 3) Milk and Cheese; 4) Meat, Poultry, Fish and Beans; and 5) Fats, Sweets and Alcohol.

Calculated Nutrient Content: The nutrient content of a food, diet or food recipe calculated from food composition tables and not determined directly by analysis of that specific food.

Index of Nutritional Quality (INQ): A concept which quantitatively evaluates the nutritional value of a food or diet. The INQ method compares the nutrient value of a food to its caloric value relative to the Recommended Dietary Allowances for nutrients and calories.

Nutrient Density: A comparison of the nutrient content of a food or diet to its energy (kilocalorie) content. A food that is nutrient dense has a high proportion of nutrients relative to the energy provided.

Nutritional Status: The health condition of an individual as influenced by his intake and utilization of nutrients, determined from the correlation of information obtained from physical, biochemical, clinical and dietary studies.

Recommended Dietary Allowances (RDA): The specific term used by the Food and Nutrition Board of the National Research Council of the National Academy of Sciences for recommendations for daily intake of specific nutrients for groups of healthy individuals according to sex and age. The RDA, designed to be adequate for practically all the population of the United States, allow a margin of safety for individual variations, except for kilocalories.

REVIEW OF LITERATURE

Undernutrition in the U.S.

An intense interest in the American diet began in the 1960s when the U.S. Senate Subcommittee on Employment, Manpower and Poverty (1967) conducted hearings in response to a growing body of evidence that hunger and servere malnutrition existed in certain parts of the United States. The Subcommittee hearings documented that hunger did, in fact, exist, but that knowledge of the prevalence and location of hunger and malnutrition was almost non-existent. The Surgeon General testified before the Subcommittee, that "the Federal Government did not know the extent of hunger or malnutrition anywhere in the United States" (U.S. Senate, 1967).

At approximately this time, early reports became available from the fifth Household Food Consumption Survey (HFCS) conducted by the U.S. Department of Agriculture (USDA, 1969). The USDA has conducted household food consumption surveys approximately every ten years since the 1930s. Data from these surveys have been the primary sources of information on the kind, amount and monetary value of foods consumed by families and individuals in the United States (USDA, 1979a). Initially, the surveys concentrated only on food used in the home. In 1965-1966, for the first time, data were collected on individuals' food consumption away from home, as well as from the home food supply.

Data obtained in the spring quarter of the 1965-1966 HFCS (USDA, 1969a) represented total household food consumption and food intakes of individuals in 7500 households in the forty-eight contiguous states. Household food consumption levels were also determined for 2500 additional households during the three subsequent seasons of 1965-1966. Values of seven nutrients - protein, calcium, iron, vitamin A, thiamin, riboflavin and vitamin C - were calculated for each household and individual.

The results of this survey indicated that many people in the United States reported consuming diets that did not meet nutritional standards suggested by the Food and Nutrition Board (1968). Approximately one-half of the households surveyed had diets that failed to meet the Recommended Dietary Allowances (RDA) (Food and Nutrition Board, 1968) for one or more nutrients. About one-fifth of the households in the sample had "poor" diets, defined by USDA as providing less than two-thirds of the RDA for one or more nutrients. "Good" diets were defined as those for which the calculated consumption values of the seven nutrients equaled or exceeded the RDA for all household members. The number of "good" diets in the 1965 survey decreased ten percent from the previous HFCS of 1955-1956. The number of "poor" diets increased six percent during the same time interval.

As income levels increased, dietary adequacy also increased. Nearly two-thirds (63%) of household with incomes less than $3000 had diets that did not meet the RDA for one or more nutrients. Slightly more than one-third (37%) of households with incomes greater than $10,000 had similarily "poor" diets.

The concurrent survey of food consumed by individuals within households provided a more accurate assessment of dietary adequacy than the household portion of the survey. Individual food consumption data represented food actually eaten on an "edible portion" basis, whereas the household data were based upon food "as purchased" or "available for consumption."

Findings of the individual segment of the HFCS indicated insufficient dietary intakes of vitamins A and C, thiamin, riboflavin, iron and calcium among significant numbers of the sample population. Calcium and iron intakes were greater than thirty percent below the RDA for several population subgroups, particularly adolescent girls and women. The dietary iron content for many infants and children younger than three years was approximately fifty percent below recommended amounts. Vitamin C intakes of infants younger than two months were less than the recommended allowance. Other specific nutrient deficiencies were found among diets of adult women, adolescent girls and boys and elderly men and women. Individuals with incomes less than \$3000 and those who resided in the Southern region of the United States had nutrient intake levels below recommended amounts for calcium, iron, vitamin A and vitamin C.

It appeared from the results of the Household Food Consumption Survey, 1965-1966 that the quality of household food consumption had deteriorated since the previous survey. Certain population subgroups appeared to be at higher risk for undernutrition but an exact determination of who was undernourished was not possible from this survey.

A number of other nutrition-related events occurred about the same time that the 1965 household consumption figures were published.

In April, 1968, the privately sponsored Citizen's Board of Inquiry (1968) into Hunger and Malnutrition published an independent report on hunger in the United States. Using national data, studies of specific regional areas and case histories, they estimated that ten to fourteen million Americans were "going hungry." That same April, the Columbia Broadcasting System (1969) aired a documentary entitled "Hunger in America" which demonstrated dramatically that countless Americans were seriously undernourished. These reports together with results from the HFCS, 1965-1966 and hearings before the Senate Subcommittee on Employment, Manpower and Poverty, provided the impetus for governmental action to investigate and alleviate nutritional problems in the United States.

Immediate measures to alleviate hunger were provided by the addition of an emergency food and medical services amendment to the Economic Opportunity Act (1967) authorizing 75 million dollars to help pay the purchase price of food stamps and provide for other assistance. In addition, in an amendment to the Partnership for Health Amendment of 1967, Congress directed the Secretary of the Department of Health, Education and Welfare (USDHEW), in consultation with other officials of the federal government and of the states, to "make a comprehensive survey of the incidence and location of serious hunger and malnutrition in the United States" (USDHEW, 1972). At the insistence of Senator George McGovern, the Senate also established the Select Committee on Nutrition and Human Needs to "study the food, medical and other related basic needs among the people of the United States" and to report such recommendations as it finds necessary "to establish a coordinated program which will assure every U.S. resident adequate food, medical assistance, and other related basic necessities of life and health" (U.S. Senate, 1968a).

To fulfill the Congressional mandate for a nutrition survey, the Secretary of the USDHEW directed the Nutrition Program of Health Services and Mental Health Administration, National Center for Chronic Diseases, Public Health Service to undertake the National Nutrition Survey, subsequently entitled the Ten-State Nutrition Survey, 1968-1970 (USDHEW, 1972). The Ten-State Nutrition Survey was the first comprehensive attempt to assess the nutritional status of the American people. Emphasis was placed upon determining nutritional status and dietary practices of low-income people. The statistical sample of approximately 40,000 people was drawn from areas shown by the 1960 census to have the lowest average income within ten states located in different geographic regions of the U.S.: California, Kentucky, Louisiana, Massachusetts, Michigan, New York, South Carolina, Texas, Washington and West Virginia. The population sampled did not necessarily represent all low-income people in a state and the sample did include some higher income people who lived in the selected areas.

Nutritional status was evaluated by data from clinical evaluations, anthropometric measurements, hemotocrit and hemoglobin determinations, urine analyses, dental examinations and dietary food intake records. Selected smaller groups such as infants and young children, adolescents, pregnant and lactating women and the elderly, were given more detailed biochemical tests and dietary evaluations.

The study group was mostly white but also included blacks, Mexican-Americans and Puerto Ricans.

The results of this survey indicated the occurrence of malnutrition or a high risk of developing nutritional problems among a considerable proportion of the survey population, especially blacks, Spanish-Americans and persons with low-incomes. Although income was a major determinant of nutritional status, other factors such as cultural, social and geographic differences also had a significant impact upon nutrition levels.

The diets of individuals of low-income did not differ from middle income groups in terms of the nutrient densities of their diets. However, the amount of calories provided by the available food was directly related to family income. The total amount of food consumed by children in low-income families was limited and this insufficiency was reflected in poor growth performance. The caloric content of diets and the intakes of all nutrients studied were lowest for blacks and Mexican-Americans living in the Southwest. Ironically, obesity was found to be a problem among adult females, particularly black women, and also among children and adolescents.

There was more evidence of unsatisfactory nutritional status among adolescents, age 10 to 16 years, than in any other age group. Riboflavin and vitamin A status were poor among young people of all ethnic groups, with Mexican-Americans in Texas having the highest incidence of low vitamin A levels. Low levels of hemoglobin indicated widespread iron deficiency anemia, especially among women of child-bearing age, but also among adolescent and adult males.

The educational attainment of the person usually responsible for buying and preparing the family food had an effect upon the nutrition of children under the age of 17 years. As the homemakers educational level increased, the evidence of nutritional problems in the children decreased.

In general, the results of the Ten-State Nutrition Survey revealed that a significant number of individuals in the population surveyed were malnourished or at high risk of developing nutritional problems. The greatest degree of malnutrition was among those persons with lowest income, more commonly among blacks and Spanish-Americans than among whites. The results also demonstrated that the elements of malnutrition varied from one locality to another and among different populations within localities. Consequently, conclusions and recommendations which emerged from this study focused upon a diversified approach for alleviating malnutrition. Proposals for developing solutions for nutritional problems emphasized identification of high-risk groups by social, cultural and economic characteristics and development of unique nutrition intervention programs for each population subgroup (USDHEW, 1972).

The Preschool Nutrition Survey (Owen et al., 1974), which was also funded by the USDHEW, was conducted in 1968-1970, during approximately the same time interval as the Ten-State Nutrition Survey. The Preschool Survey was designed to provide an overview of descriptive data on the nutritional status of a cross-sectional sample of preschool children throughout the United States. This objective contrasted with the Ten-State Nutrition Survey, which focused upon the population presumed to be most at risk because of poverty.

The survey procedures included dietary studies, clinical evaluations, dental examinations and biochemical tests along with detailed socioeconomic information. Dietary interviews were conducted with 3441 children ages one to five years. Clinical examinations and biochemical tests were made on about two-thirds of these children. Special dietary standards were established for this study and used with dietary data to estimate the proportion of children who had inadequate intakes of energy and selected nutrients.

In this study, age, race and socioeconomic status were important variables influencing eating patterns. Protein intakes were similar for all children and judged adequate to meet needs. Vitamin C intakes of many children in the low income group were less than the recommended standard. The major problem, however, was insufficient food among the poorer children who had lower than average nutrient intakes.

Clinical examinations revealed a few signs of malnutrition, mostly among the poor. Black children were found to be taller and heavier than white children. In contrast, for every age and sex group, white children had greater skinfold thickness than black children. Biochemical tests showed lower hemoglobin levels among the black children than among the white. Mean hemoglobin values were lowest among the poor and increased with increasing income and age. Children who had lower dietary intakes, lower biochemical values, and who were small for their age were characterized as showing evidence of nutritional risk.

General findings of the Preschool Survey indicated that evidence of "nutritional risk" was clustered among preschool children of lower socioeconomic status. The major problem confronting those children at "nutritional risk" was insufficiency of food. It was also evident from the survey that racial, genetic and socioeconomic factors were important determinations of growth, nutrition and health. Nevertheless, the authors of this study felt that the results indicated that socioeconomic status correlated poorly with the nutritional quality of diets, with the possible exception of vitamin C. Among socioeconomically depressed people the problem appeared to be lack of sufficient quantity of food rather than nutritional quality. The authors suggested that nutrition education programs be general in scope and directed at the entire population rather than focusing upon re-education directed only at the poor.

The findings of these three surveys made apparent that many Americans suffered from poor nutrition in spite of advances in nutrition knowledge, food technology, medicine and sanitation which had helped to reduce the prevalence of nutritional deficiency diseases. The results and conclusions drawn from these surveys provided the basis for recommendations to the Federal Government for alleviating nutritional problems in the United States. Recommendations stressed that solutions to the various types of nutritional problems should vary among segments of the population having different social, cultural and economic characteristics (USDHEW, 1972).

During 1968-1970 the newly formed Senate Select Committee on

Nutrition and Human Needs began to conduct hearings and studies in an attempt to evaluate the nation's programs in food, nutrition, education, health and welfare. Their purpose was to study the adequacies and shortcomings of these programs in order to find ways to meet the nutritional and other basic needs of Americans. The hearings provided an opportunity for scientists, legislators, government employees, industry representatives and the poor to testify and assist in formulating legislative support for improvement of nutrition, health and other concerns for the needy (U.S. Senate, 1968b).

In August, 1969, the Select Committee published an interim report in which they gave major emphasis to reform and expansion of the food stamp program (U.S. Senate, 1969). Committee members also suggested that to assure adequate food, medical assistance and other basic necessities to all Americans, a comprehensive and coordinated program would have to be established. Such a program would necessarily include: 1) improvement in the outreach of food assistance programs through greater involvement of the Office of Economic Opportunity on the local level; 2) establishment of educational programs to inform citizens, particularly low-income people, of the nutritional and economic aspects of food acquisition and use and; 3) increased research on the incidence and location of hunger and malnutrition, the kinds of foods which should be developed and the relationship between malnutrition and intellectual and physical development; 4) expanded efforts to deal with malnutrition during pregnancy, infancy and childhood; 5) improvement of the access of the poor to fortified and enriched food products through private distribution systems; and 6) increased use of direct commodities to supplement provisions made under the food stamp program. Committee members reported:

> Both our own conclusions and the stated commitment of the administration would suggest that we cannot meet the problem of hunger and malnutrition unless we do so in a comprehensive manner - a coordinated program, which utilizes to the fullest extent possible our educational, health and community resources and the private food industry. (U.S. Senate, 1969, p. 39).

As a result of congressional interest and nutritional survey findings, the U.S. President called the White House Conference on Food, Nutrition and Health, held in December, 1969. This Conference was to advise the President, Congress and the American people on developing a national policy aimed at eliminating hunger and malnutrition due to poverty, improving the national health status of all Americans and focusing national attention and national resources on nutritional problems in the U.S. (White House Conference, 1970). One of the important characteristics of the Conference was its broad range of participants, who were consumer advocates, academicians and nutrition professionals, food industrialists, government officials, politicians and program beneficiaries.

During the conference, more than 30 panels and task forces considered social and political issues, as well as problems of food and nutrition in the U.S. They made 450 recommendations on food assistance for the poor, nutrition and health programs, regulation of food production and supply, nutrition education and other pertinent topics. Specific recommendations which were made included: 1) establishment of a nutrition surveillance system under the USDHEW for monitoring the effectiveness of nutrition programs; 2) improvement of health services for all people including the means for adequate food and nutrition education; 3) provision of services as well as food for older persons; 4) innovative uses of the media for nutrition education and 5) more adequate food programs including free food stamps and free school lunch or a system of cash supplementation to maintain all incomes at a specified level. Conference participants also noted that there was no single agency coordinating food, nutrition and health programs. They recommended the appointment of a special assistant to the President, specializing in nutrition problems and the establishment of an office of nutrition that would develop programs and priorities to survey and monitor state, county and local nutrition and health systems and plan appropriate programs for the USDHEW and other federal agencies.

Many recommendations which were made, such as production of more healthful food, institution of effective wide-scale nutrition education and development of a national nutrition policy, involved complex decision making and long-range goals and programs. However, immediate measures were taken by the federal government in response to some of the recommendations of both the White House Conference and the Senate Select Committee on Nutrition and Human needs.

A follow-up in 1971 to the 1970 White House Conference noted some achievements that had already occurred during one year. These included revision and expansion of the food stamp program, replacement of most of the commodity programs by food stamps, expansion of the school lunch program with better provision for free and part pay lunches, training of aides by the USDA Expanded Food and Nutrition Education Program (EFNEF), improvements in food labeling and enactment of a new labeling law and research by the Food and Drug Administration (FDA) into additives, food-borne diseases and environmental contamination (White House Conference, 1971).

To define more clearly nutrition problems and their effects upon health, a continuing national nutrition surveillance system was established by the National Center for Health Statistics (NCHS) within the U.S. Department of Health, Education and Welfare (USDHEW, 1975). The Nationwide Health and Nutrition Examination Survey 1971-1972 (NHANES I), conducted by the NCHS, was the first nutrition survey in the U.S. of a true sample of the civlian non-institutionalized population in a broad range of ages, 1-74 years. The purpose of the survey, and of the surveillance system generally, was, and is, to measure the nutritional status of the U.S. population and to monitor the changes in this status over time (USDHEW, 1973).

In the NHANES I the evaluation of nutritional status was based upon four major nutrition components: 1) dietary intake based on a 24-hour recall and food-frequency questionnaire; 2) biochemical levels of various nutrients based on assessment of blood and urine samples; 3) clinical signs of possible nutritional deficiencies and 4) anthropometric measurements.

Preliminary findings of the NHANES I (USDHEW, 1973) based upon 10,126 individuals showed that iron was the nutrient most often below standard in population groups. The only group which met the standards for iron intakes were males, ages 18-44, although many black males failed to meet standards. Anemia, as shown by low hemoglobin and hematocrit values, was found among older age groups, more among blacks than whites and more at low income levels.

Most age groups, regardless of race or income levels, had vitamins A and C intakes that approached or exceeded standards. However, intakes of vitamins A and C were below standard in 73 percent of lower income white women, ages 18-44, and in higher income black girls. Black children between the ages of one to five years showed the highest prevalence of low serum vitamin A values. Serum vitamin A values were generally low among blacks and among lower income groups.

Children and adolescents in income groups above the poverty level had significantly larger values for heights, weights and skinfolds than those in lower income groups. A high prevalence of obesity was found, especially among women. Obesity ranged from 18.9 percent for white women, ages 20 to 44 years to 32.4 percent for black women, ages 45 to 74 years. Black women were identified as the highest risk group for the development of and mortality from certain chronic disease such as hypertension, heart disease and diabetes.

The conclusions which were generated by the results of this survey were similar to those of the Household Food Consumption Survey, 1965-1966, the Ten-State Nutrition Survey and the Preschool Nutrition Survey. The three nutritional status studies showed widespread prevalence of nutritional problems such as obesity, retarded growth and development and iron-deficiency anemia. All of the surveys provided evidence that those who failed to attain a diet optimal for health could be found at every socioeconomic level. The reasons appeared to be numerous and complex, but many people in a variety of situations were affected by improper diet. Recommendations stressed the need to implement control and preventative programs directed toward identified high risk groups.

During the major part of the next decade, the 1970s, the Senate Select Committee on Nutrition and Human needs worked each year to expand existing food programs, while at the same time adding new programs to fill in the gaps. Some of the most visible areas of growth included: 1) the food stamp program, which reached fewer than 3 million low-income people in 1969, but by 1979 provided food support for approximately 17 million people; 2) a uniform, national subsidized school lunch program, which was established in 1970 and reached almost 27 million children by 1979; 3) the summer food program, which served fewer than 100,000 children in 1969, but by 1979 reached more than 2.5 million children; 4) the Special Supplemental Food Program for Women, Infants and Children (WIC) which was established in 1972 to assist mothers, infants and children at nutritional risk and 5) the Title VII Elderly Nutrition Program, which emerged in 1972 with an authorization of 100 million dollars and by 1977 had doubled expeditures and was serving 2.4 million elderly (Mayer, 1973; USDA, 1979a).

By 1979, upwards of nine billion dollars were spent annually in attempts to assure adequate opportunity for disadvantaged people to participate in the U.S. food supply (Hegsted, 1979a). In addition, improvements in agricultural production and changes in food processing and delivery made a large variety of foods accessible to the majority of the population. Nutrition education and information programs focused on communicating research-derived nutrition concepts and dietary guidance to consumers to help them make informed food choices and to maintain diets which promote good health (USDA, 1979a).

Food assistance, agricultural improvements and nutrition education programs do not, of course, guarantee that everyone in the United States has an adequate intake of essential nutrients. Consumers are assumed to make decisions which reflect their desire to have and maintain a balanced and adequate diet. Obviously, this assumption is not without exception. The increasing complexity and changing character of the food supply provide the consumer with a large, and sometimes confusing, array of food products from which to choose. Nutrition surveillance systems continue to monitor changes in food consumption practices and nutritional quality of diets to assure that food consumed is adequate to meet needs.

The USDA food consumption surveys have been the principal means employed by the government for monitoring American diets. The sixth survey, the Nationwide Food Consumption Survey, was conducted during 1977-1978. Information on changes in household food consumption and individual diets has recently become available (USDA, 1980b; 1979c).

Differences in the quantity of food used by households in the Spring of 1977 and the similar survey in the Spring of 1965 were reflected in differences in energy and nutrient levels in food used. There was a ten percent decline in the level of food energy, probably due to a decreased use of milk and dairy products, bread and cereals, fats and oils and most foods high in sugar (USDA, 1979b). The decline in food energy was not accompanied by a decline in the levels of vitamins or iron. Only the level of calcium in food used decreased. Consequently, the food available in the households in the Spring of 1977 had, on the average, a higher nutrient density than that used in 1965. The average nutrient levels for households in the lowest income group generally improved more than those in other income levels. In general, the nutrient levels and quantities of food used were more uniform at various income levels in 1977 than in 1965 (USDA, 1979b).

Comparison of the level of individual food intake, based upon 24-hour recall data, showed that caloric intakes of all sex and age groups were lower in 1977 than 1965 (USDA, 1979c). Intakes of protein also declined except for men and women over 65 years of age, and fat intake declined for all sex-age gorups. Vitamin C consumption increased considerably from 1965 to 1977.

Intakes of infants showed the sharpest decline of all sex-age groups from 1965 to 1977 for food energy, protein, fat and calcium, but a large increase for iron. In the elderly age group, men and women over 65 years of age had the smallest decreases in energy, protein and fat of any group and calcium, vitamin A and vitamin C intakes were higher in 1977 than 1965 for this age group (USDA, 1979c).

Average intakes of the following nutrients met 1974 Recommended Dietary Allowances (RDA) for all sex-age groups: protein, vitamin A, thiamin, riboflavin, vitamin C and phosphorus. Vitamin B_6 intakes of infants, children and some groups of teenagers met the 1974 RDA, but intakes of adult groups were below RDA. Average intakes of magnesium were below 1974 RDA for nearly all sex-age groups. Calcium intakes in

1977 were lower than in 1965 for infants, children and teenagers. Average intakes of females 12 years and older were 25 percent or more below the 1974 RDA. Several groups of children had calcium intakes that averaged about 10 percent below the RDA (USDA, 1979c).

Evaluation of the composition of American diets and changes which occur in food and nutrient consumption patterns is essential for planning effective intervention programs to alleviate nutritional problems in the United States. If nutritional interventions such as food assistance, food labeling and fortification and nutrition education are to have an impact, they must be directed toward specific nutritional problems where they exist in the population. Whatever nutritional problems exist, for otherwise healthy individuals, are obviously dependent upon foods consumed. Food consumption, in turn, is affected by such factors as sex, age, income level, ethnicity and a variety of other characteristics and influences (Hegsted, 1973). Utilizing these factors to determine food and nutrient consumption patterns within the population provides a means of identifying target groups for nutrition intervention based upon nutritional needs.

Overnutrition in the U.S.

Interest in the American diet has continued to be stimulated in recent years by research which suggests that dietary factors may be involved in the development of a number of chronic diseases which are among the nation's primary health problems. The concern results from a growing recognition that the kinds and amounts of food and alcohol consumed by the public and the style of living in a sedentary society contribute to problems of overnutrition as well as undernutrition.

The nature and composition of the American diet has changed markedly during this century. Shifts in the kinds and amounts of foods making up the U.S. diet have altered the levels of nutrients available for consumption (Page and Friend, 1978). The proportion of calories from fat in the food supply has increased by 25 percent while the proportion from carbohydrate has decreased by approximately the same amount. The increase in fat consumption is mainly from increased vegetable fats and oils. Fat now supplies an average of 40-45 percent of total dietary calories. The decrease in carbohydrate consumption is largely from lower consumption of cereal grain products and potatoes, coupled with higher consumption of animal products (Page and Friend, 1978). The levels of total sugars, i.e., refined cane and beet sugar and sugars occurring naturally in foods, has increased by 25 percent. As a result, sugars now account for 53 percent of total carbohydrate whereas in 1909-1913 less than one-third came from sugars.

Protein consumption has ranged from an average of 95 to 102 grams during this century, clearly adequate in relation to nutritional needs of the population. The most significant change with protein has been the shift in its sources. Animal products now account for more than two-thirds of the protein as compared in the equal contributions from animal and vegetable products in the early part of the century (Page and Friend, 1978).

Shifts in the level of energy-yielding nutrients have altered the total calories available from the U.S. diet and the share accounted for by each of the nutrients (Friend, 1967; Page and Friend, 1978). During 1909-1913 fat provided 32 percent of total calories and carbohydrate, 56 percent. By 1976, the share from fat had increased to 42 percent and the share from carbohydrate had dropped to 46 percent. Protein has provided approximately 12 percent of calories throughout the century (Page and Friend, 1978).

The average total amount of calories available has decreased, but only by about five percent, from 3480 calories in 1909-1913 to 3300 calories in 1976. The fact that the decline in the calorie level has been no greater may be related to one of the nation's major health problems, obesity. Americans are more sedentary today than formerly and thus have reduced energy needs. However, the amount of food being used, measured in calories, is almost the same as at the beginning of the century (Page and Friend, 1978).

When the intake of calories exceeds that which is expended for growth, maintenance and activity, the excess remains deposited in the body as fat. Obesity, overweight resulting from excess body fat, has been related as a risk factor to the development of diabetes, gallbladder disease and hypertension (Van Itallie, 1979). In association with other risk factors, it can contribute significantly to heart disease. In addition to the increased risk of developing certain diseases, there are social, psychological and economic costs of obesity.

Thirty-five percent of women between ages 45-64 with incomes below poverty level and 29 percent of those with incomes above poverty level are considered obese (USDHEW, 1973; Surgeon General, 1979).

Comparable figures for men are five and 13 percent. The prevalence of obesity increases with increasing age. According to the National Center for Health Statistics (NCHS) 30 percent of males and 49 percent of females consider themselves to be overweight (USDHEW, 1980).

In a review of studies of the relationships between nutrition and diabetes, West (1976) stated that the degree and duration of adiposity is the one factor most strongly and consistently associated with the prevalence of adult-onset diabetes. Diet prescription is important in the treatment of diabetes, but there is little evidence that a specific dietary component, such as excess sugar, can be directly linked to the cause of the disease. However, there is substantial evidence that excessive food intake leading to obesity is strongly associated with the prevalence of diabetes.

Obesity is not the only nutrition-related health problem. Cardiovascular disease and cancer are other public health concerns that may be diet related. Hypertension is a risk factor for coronary heart disease (CHD), as well as an important factor in other diseases such as renal failure, stroke and congestive heart failure. Recent blood pressure measurements of adults indicated a prevalence rate of 18 percent for hypertension among individuals 24 to 74 years of age (USDHHS, 1981). Black adults had higher rates than white adults and the prevalence of hypertension increased rapidly with age, particularly for women. Obesity aggravates hypertension, but the exact relationship is unknown. As weight increases, blood pressure rises; the greater the weight gain, the greater the rise in blood pressure. When people lose weight, their blood pressure generally decreases (USDHEW, 1980). High dietary salt intake may produce high blood pressure, particulary in susceptible people. A sodium-restricted diet along with drug therapy is an accepted treatment for lowering blood pressure (Tobian, 1979). However, whether or not a high level of sodium consumption is a causal factor in the development of hypertension is controversial.

A great deal of research has been conducted in an attempt to link diet with coronary heart disease. The link between diet, particularly fat, and CHD is indirect. Diets high in saturated fat and/or cholesterol raise an individual's blood lipid levels, particularly the serum cholesterol level. Elevated blood lipids induce atherosclerosis and individuals with atherosclerosis are highly susceptible to coronary heart disease. Epidemiological studies among large populations reveal strong relationships between the number of heart attacks, the incidence of atherosclerotic heart disease, hyperlipidemia, hypercholesterolemia and the diet of the population. Generally, population groups at high risk from CHD have diets higher in total fats, saturated fats and cholesterol (Glueck, 1979; McGill, 1979).

Based upon evidence from these studies plus animal and human experiments, some scientists advocate a diet for the U.S. population that is lower in fat, particulary saturated fat and cholesterol. Others believe that dietary modification should apply only to those in the population who have evidence of the development of CHD or its associated risk factors.

The association between diet and cancer is more tenuous than that between diet and heart disease. Studies in human populations have suggested a number of possibilities: that high consumption of animal protein or low consumption of fiber from plant sources may be linked to colon cancer and that high consumption of fats, both saturated and unsaturated, may be linked to colon cancer and to hormone-related cancers of the ovary and prostate (Surgeon General's Report, 1979). Most of the possible relationships between diet and cancer are controversial. Although dietary changes may benefit the population by decreasing the risk of cancer, evidence to substantiate this is lacking at the present time (USDHEW, 1980).

In January, 1977, the Senate Select Committee on Nutrition and Human Needs, concerned by changes in American dietary patterns and their relation to health, released the first comprehensive statement by the federal government on risk factors in the American diet. The Committee linked changes in dietary patterns with increased incidence of "killer diseases": heart disease, cancer, obesity and stroke. To reverse the trend and to combat these diseases, the Dietary Goals for the United States (U.S. Senate, 1977a) and changes in food selection to meet these goals, were outlined.

This first edition of the Dietary Goals set six basic goals for changing the fat, cholesterol, carbohydrate, sugar and salt levels in the national diet. Recommendations were based upon committee hearings on the relationship of diet to disease, the 1974 national nutrition policy hearings, guidelines by governmental and professional organizations in the U.S. and other countries, and a variety of expert opinions (U.S. Senate, 1977a). The first set of Dietary Goals stimulated extensive discussion and controversy, resulting in further hearings which included testimony from additional researchers, government health officials and representation of the agricultural and food industries (U.S. Senate, 1977b). A second edition of the Dietary Goals was released in December, 1977 and included an additional goal which stressed the need for maintaining or achieving appropriate body weight (U.S. Senate, 1977b). Along with the Dietary Goals were recommendations for selecting foods.

The Dietary Goals remain controversial and strong arguments exist both for and against their endorsement. The most common criticisms have been that there is not enough evidence to make such general recommendations, that the possible benefits to be derived have not been proven and that dietary recommendations should be tailored to individual needs (American Dietetic Association, 1979; Olson, 1979; Simopoulos, 1979, Food and Nutrition Board, 1980b). Proponents of the Dietary Goals have felt that the available data are conclusive enough to lead to sensible and consistent dietary recommendations to moderate the dietary practices of most Americans (Hegsted, 1979a; 1979b).

In the Surgeon General's Report (1979) a number of guidelines were suggested which were compatible with the U.S. Dietary Goals, but did not recommended specific levels of consumption. The report stated that, given what is already known or strongly suspected about the relationship between diet and disease, Americans would probably be healthier as a whole if they followed certain dietary guidelines (Surgeon General's Report, 1979). The USDA and USDHHS have jointly developed a set of Dietary Guidelines for Americans (USDA and USDHHS,

1980) which were derived, in part, from the U.S. Dietary Goals, but also did not recommend specific levels of consumption. These two government departments concluded that the extensiveness of evidence suggested that recommendations could and should be made so that Americans could increase their awareness of the role of diet in health promotion and disease prevention. The belief is that Americans are anxious to have dietary advice from reliable, unbiased sources (Hegsted, 1980; USDA and UDHHS, 1980).

A recent survey on health-related food choices supports the position that Americans are concerned about nutrition and health, but that they are confused about how to harmonize health and nutrition goals with food practices (USDA, 1980b). This survey conducted by the Economics and Statistics Service (ESS) sought to provide data linking consumer health and nutrition concerns with stated food use practices. Participants were asked what food changes they had made for health or nutrition reasons in the previous three years and then, subsequently, were asked if they had any health or nutrition concerns.

Results of the survey indicated that approximately 15 to 20 percent of the households reported using less of high fat and cholesterol foods such as bacon, eggs, beef and sausage. One to 10 percent indicated changes in amounts and types of fats and oils in the direction of smaller amounts and toward use of soft margarine and vegetable oils. Twenty-five percent reported eating more fruits and vegetables and about one in seven households reported substituting whole-grain bread for white bread, although ten percent of households decreased bread consumption. Twenty-two percent of the sampled households reported reducing use of salty foods and snacks for health or nutrition reasons whereas one-third reported using less sugar and sugary foods.

Sixty-four percent of sampled households in this survey reported that they made dietary changes for health or nutrition reasons in the three years prior to the survey. Although a variety of concerns were cited as reasons for making food use changes the most frequently mentioned were: 1) concerns about excess sugar, more commonly among high income groups and those with more schooling; 2) concern about calorie intake or weight control, especially among females and for males and females alike in the 35 to 49 year old age range and among higher income households; 3) concern about salt intake or blood pressure control, more prominently among blacks and older age groups; 4) concern about fat intake, particularly among respondents with the most schooling and 5) concern about cholesterol intake, most commonly among higher income and more highly educated groups.

It appears then, that as knowledge of the relation between diet, health and disease has increased, the food consumption behavior of Americans has become a national concern for nutrition professionals, government officials and consumers, alike. Evaluation of food and nutrient consumption data is essential for determining the composition of diets, identifying dietary patterns and determining the kind, degree and prevalence of dietary problems which may exist. There is a need for reliable and extensive baseline information on current dietary status for use in planning and evaluating food policies, dietary goals, nutrition education efforts and other food and nutrition programs.

Need for Ongoing Nutrition Surveillance

Surveillance of the nutritional status of the population has become a subject of increasing concern to both national governments and technical agencies in the fields of food, agriculture and health. A United Nations (UN) Expert Committee on Methodology of Nutritional Surveillance emphasized the importance of surveillance activities:

> National surveillance is an essential instrument for the detection of nutrition problems, for the formulation of policy and for the planning and evaluation of action programmes for both development and emergency situations. Without an adequate surveillance system at the national and local levels, a progressive deterioration of health may proceed undetected.... (UN Expert Committee, 1976, p. 53).

Surveillance should provide ongoing information about the nutritional conditions of the population and factors that influence them. This information would provide a basis for decisions to be made by those responsible for policy planning and management of programs relating to improvement of consumption patterns and nutritional status (UN Expert Committee, 1976).

Surveillance, according to these descriptions, is not an isolated activity but goes hand in hand with the formulation and execution of nutrition policy. In the United States, the appropriate scope of national nutrition policy has yet to be defined. Efforts in this direction have been made by the Senate Select Committee on Nutrition and Human Needs (U.S. Senate, 1974; 1975) the National Nutrition Consortium (1974), the American Dietetic Association (ADA Position

Paper, 1980) and the Department of Health, Education and Welfare (USDHEW, 1976), now the Department of Health and Human Services. Central to these recommendations for national nutrition policy is a concern with nutritional surveillance and food consumption behavior. The American Dietetic Association, in defining goals of a national nutrition policy, stated:

> Surveillance of food consumption and nutritional status of the population should be conducted on a continuing basis ... to determine nutrient intake and ... identify individuals who may be at risk ... (ADA Position Paper, 1980, p. 596)

The USDHEW nutrition policy statement also emphasized nutritional surveillance:

> Monitoring activities shall be needed to establish the nutritional status of the nation. This shall be accomplished through general surveillance activities at the national level and through local surveys of high-risk populations. It should include monitoring trends of the eating habits of the American people .... The results of surveillance and monitoring shall be linked programatically to activities of the Department to promote and enhance the health and well-being of the population (USDHEW, 1976, p. A-1-3).

Broadly stated, U.S. nutrition policy in the past has emphasized assurance of adequate nutrient intake using the Recommended Dietary Allowances as guidelines. This policy has been quite successful and severe nutritional deficiency disease is now rare in the U.S. (Hegsted, 1979a). However,

> ... this does not deny that there are people who, because of poverty, ignorance or neglect, fail to get an acceptable diet. Everyone agrees that we must develop better methods of surveillance and monitoring to try to identify individuals or groups in need .... (Hegsted, 1979a, p. 535)

> The objective of any adequate nutrition program must be to prevent the disease from developing - not to cure the disease after it develops. Thus if there is any appreciable amount of clinically evident disease in a population, the surveillance system has failed. Clearly, a system that relies largely on counting the number of malnourished persons is inadequate. The system must identify "high risk groups" and call for programs that will reduce the risk (Hegsted, 1973, p. 81).

As increasing attention has been given to the problems of overnutrition, in addition to problems of undernutrition, the emphasis of nutrition policy has shifted toward moderation of American dietary patterns and limitation of various food and food constituents (Hegsted, 1979a). Estimates by the Senate Select Committee on Nutrition and Human Needs indicated that an average 20 percent reduction in incidence, prevalence and cost in chronic diseases and other health problems could be realized with improved nutrition (U.S. Senate, 1977b). The population is composed of individuals whose nutritional status places them in one of a variety of risk categories for developing ill health at some future date. Everyone falls into some risk category for morbidity or mortality for chronic diseases and, thus, everyone could benefit from further nutrition education and modification of diets (Frankle and Owen, 1978, p. 170).

A major purpose of nutrition policy is to modify food consumption (Hegsted, 1979a). The shift in emphasis toward more concern about over-consumption of certain foods or food constituents does not mean less concern about adequate intake of essential nutrients. Policy makers are interested in the nutritional well-being of the total population, but particularly of those in the population who are affected by malnutrition due to under- or over-consumption. Resources are not available to reach 100 percent of the population with nutritional intervention programs, thus a surveillance system is essential for identifying that portion of the population most in need of nutritional services (Frankle and Owen, 1978, p. 170).

Currently, the United States has an unorganized system of nutritional surveillance distributed throughout various private and governmental agencies. These include the Department of Agriculture, Department of Defense, Department of Health and Human Services, Veterans Administration, National Center for Health Statistics, Food and Drug Administration, Communicable Disease Center and Environmental Protection Agency (U.S. Senate, 1976). The types of studies which have been completed are equally diverse. They range from assessment and monitoring of food supply to food production costs to food consumption. Other data are available from studies on the nutritional value of foods, ingestion of contaminants, alcohol consumption, costs of food purchases and of price indices related to food (U.S. Senate, 1976).

In many cases there are legitimate reasons for separate or specialized surveys and programs; nutrition crosses a number of traditional disciplinary and departmental boundaries: agriculture, health, education and food safety. Many programs are designed for specifically defined purposes, but others are directed toward the same general concerns and could benefit from interdisciplinary focus and interdepartmental cooperation. In this connection, the Department of Agriculture and the Department of Health and Human Services are currently studying ways for improved cooperation and coordination between the individual food intake segment of the USDA Nationwide Food Consumption Survey and the USDHHS Nationwide Health and Nutrition Examination Program (Habicht et al., 1978).

It is not necessarily desirable, or even possible, to combine into one survey all elements of nutritional status with which a surveillance system must be concerned. The characteristics of many nutritional problem situations can vary with ecology, resources and production, and market economy of the food supply system (U.N. Expert Committee, 1976). Socioeconomic, demographic and cultural factors all affect individual ability to procure and utilize food (Owen et al., 1974). Health indicators such as morbidity and mortality statistics and availability of health services can reflect the occurrence of present or past nutritional problems. Obviously, not all of these measures can be made in one survey. Measurements which are considered most specific for surveillance of nutritional diseases are growth and body dimensions, clinical signs and symptoms, biochemical values and food and nutrient intakes (U.N. Expert Committee, 1976; Christakis, 1979).

Clearly, food consumption surveys deal with only one aspect of nutritional surveillance. They do, however, provide valuable information regarding the composition of the American diet, dietary patterns of the population, and initial indications of food related health problems. Results of food consumption surveys provide baseline information on existing dietary status for use in assessing dietary adequacy, planning and evaluating national food policies such as fortification and labeling, constructing and revising food plans, developing nutrition education programs, and developing and administering government policies related to production, distribution and use of food (Clark, 1974; Comptroller General, 1977).

Food consumption surveys are not required by law, but the results are used in setting guidelines for mandated programs (Comptroller General, 1977). One of the primary uses of the data is to update the four USDA food plans. The plans at four different cost levels - thrifty, low, moderate and liberal - are based upon amounts of foods in each of 15 food groups that will provide a nutritious diet for different sex-age groups and for families of different sizes (Clark, 1974). By law, the thrifty food plan determines the amount of food stamps issued to low-income households (Comptroller General, 1977).

The importance of and need for ongoing food consumption and nutritional status monitoring was emphasized in a recent USDA comprehensive plan for implementing national food and human nutrition research, education and information programs (USDA, 1979a). Numerous government planning and review agencies offered lists of alternative research priorities in human nutrition. These priority lists included monitoring nutritional status, assessment of current nutrition status in terms of dietary excesses and imbalances as well as deficiencies, identification of food nutritional practices, factors determining dietary practices, and evaluation of food consumption patterns of the general population and of special high-risk subgroups. Consequently, the USDA included among its research priorities for the 1980s determination of "what people are actually eating" and identification of "factors which shape these eating habits" (USDA, 1979a).

Because of budgetary limitations imposed by the current federal administration, numerous nutrition activities at various governmental levels are being curtailed. Continued escalation of food costs can only add to the nutritional problems and concerns of the population. The prevailing mood of fiscal conservatism in government and cost consciousness among consumers increases the need for ongoing surveillance to assure that the quality of food consumption is adequate to meet the nutrient needs of the population.

Need for Alternative Analytical Methods for Evaluating Nutrition Surveys

The information gathered in food consumption surveys has contributed greatly to the understanding of dietary levels of the population and changes in food consumption patterns which occur over time. However, survey uses have evolved beyond simply measuring food consumption and developing food plans. As concern increases regarding nutrition, health and the general physical and mental well-being of the population, the need for reliable baseline reference data also increases. This is particularly true for those groups identified in past surveys, as being nutritionally vulnerable or "at risk." The periodic occurrence of the Nationwide Food Consumption Survey makes it a singularly important source of dietary data. The effectiveness of the survey in providing accurate description of dietary patterns and in eliciting corrective actions depends upon the efficiency of planning, sampling, data collection and data reduction and presentation techniques, among others (UN Expert Committee, 1976).

According to Sabry (1977), important technical considerations in conducting nutrition surveys include:

> the clear definition of the objectives, the choice of appropriate sampling frames, the utilization of valid methods for the assessment of nutritional status, and the accurate analysis and utilization of the data (Sabry, 1977, p. 2).

The Nationwide Food Consumption Survey (NFCS) can be described with regard to these considerations.

The objectives of the NFCS were stated in broad terms because of the comprehensive nature of the study. Objectives included determining the kind, amount, and money value of foods consumed by different population groups as households and as individual household members, the practices of families in the purchase and use of specific foods, and the nutritive content of foods consumed (Comptroller General, 1977). Other objectives were to measure the nutritional quality of U.S. diets, changes occurring in diets since 1965-66 (the date of the most recent survey in the series), and factors related to these changes (USDA, 1979a).

The sampling procedures were consistent with the stated objectives of collecting national household and individual food consumption across time. A stratified sample was conducted yielding 15,000 households covering the universe of all private households in the contiguous United States (Comptroller General, 1977). Individuals in institutions such as the on-base military, boarding schools, and prisons were not surveyed. Stratification divided the sample into three types of population groups: central cities, suburban areas surrounding central cities in standard metropolitan areas, and non-metropolitan areas. The sample was further segmented into four georgraphic areas: northeast, north central, south and west. The choice of sampling factors was based upon the availability of census data to allow categorization of the population.

The methodology used to obtain household and individual food consumption data were the list-recall method and the 24-hour recall plus food record, respectively. The list-recall method provides a detailed list of foods to aid the respondent, usually the person identified as most responsible for food planning and preparation, to recall foods used during the seven days prior to the interview, and the amounts and costs of these foods (USDA, 1981). A disadvantage of this method is the difficulty in estimating food wastage, that is, food fed to animals, discarded or spoiled. Preliminary findings of the NFCS indicated that food losses were sizeable at the household level (Rizek and Jackson, 1981).

Information on food intake of individual members of the household was obtained using the 24-hour recall followed by a 2-day food record (USDA, 1980c). The validity of the 24-hour recall and food records, as well as other dietary data collection methods, has been questioned (Madden et al., 1976; Garn et al., 1978). The 24-hour recall has been criticized because only one day's intake is measured and may not reflect typical eating behavior. Intra-individual variation in nutrient intakes, in some cases, has been reported to be as large as inter-individual variation when measured using the 24-hour recall (Beaton et al., 1979). Data derived from food records have also been questioned because they may cause the individual to change his normal eating habits. Underestimation of food and nutrient intakes may occur with both of these methods and investigations have been planned to estimate the effects of the 24-hour recall versus 2-day record methods on food intake data (Rizek and Jackson, 1981).

Estimates of the nutrient content of foods reported as consumed by participants in the NFCS were computed using food composition tables. Preliminary reports contained average food and nutrient intakes and money value of foods consumed for various population subgroups. The reliability of these estimates are obviously affected by the accuracy of reporting and by the limitations of dietary methodologies and food composition data. Nevertheless, consumption data are considered to be a reasonable reflection of what groups of people consume, although they do not necessarily reflect what individuals consume (Hegsted, 1979c).

Food consumption data provide indications of dietary status and potential food related health problems, but they do not reflect the nutritional status of the population. Since the nutrient needs of individuals within the population vary, and are never known, a diagnosis of inadequacy cannot be made from knowledge of nutrient intake alone (Hegsted, 1975). Biochemical, anthropometric and clinical data reflect nutritional status and only in advanced stages of malnutrition is there likely to be a strong correlation among these data and dietary intake data. Food and nutrient consumption data should be regarded as descriptive of eating patterns that may, or may not, coincide with the manfestation of malnutrition (Sabry, 1977).

The USDA food consumption survey reports have usually been descriptive in nature. These studies have primarily utilized tabular analysis in which information derived from the samples have been displayed in tabular, matrix or, sometimes, graphical form. Tabular analysis is useful and utilization of this approach has revealed many important relationships.

The USDA has expressed an interest in improving analytical methods available for nutritional status monitoring and surveillance. Analytical methods are needed to make nutritional status monitoring surveys more precise and efficient (USDA, 1979a). The UN Expert Committee on Methodology of Nutritional Surveillance (1976) has stressed the need for more precise quantification of the relationships between nutritional state, such as dietary status, and potentially related variables, such as agricultural, social and economic conditions. The use of statistical models was suggested as one means of specifying relationships and predicting the prevalence of undernutrition.

Adrian and Daniel (1976) used a statistical procedure, multiple regression analysis, to estimate the effects of selected household characteristics on food nutrient consumption. This statistical method allows determination of the relationship between a set of independent variables simultaneously on a particular dependent variable, such as nutrient intake. Results of this study indicated that variations in the independent socioeconomic variables, income, race, education and employment of the homemaker and family size, which were included in the model, explained more than 50 percent of the variation in household nutrient consumption, with the exceptions of vitamins A and C. Annual household income had a positive effect on the consumption of all nutrients except carbohydrate. The impact of other socioeconomic factors varied with different nutrients. Black households consumed significantly less carbohydrate, calcium and thiamin than other races. Households with more highly educated housewives had less carbohydrate and fats and more vitamin C, whereas those with employed housewives consumed more carbohydrate and fats.

The use of inferential statistics in this study permitted a number of useful interpretations in addition to those which could have been made by using descriptive statistics alone. The results of this study corroborated findings of previous surveys which indicated that dietary adquacy was related to economic status and other sociological factors. However, the results of the statistical analysis were used to quantify that relationship: depending upon the nutrient, more or less 50 percent of individual variation in consumption could be explained when considering the selected socioconomic factors together. The relative importance of each of these factors could also be determined. Thus, statistical inference-making procedures allowed not only for making inferences, but also provided a measure of how good the inference was by assigning a specific probability to it. By using statistical procedures the researchers had more information available to them for use in making interpretations or for designing future studies or intervention programs. For example, the fact that an average 50 percent of the variance was explained in this study might indicate a need for identifying other factors which shape peoples' eating habits, a need which has already been established by the USDA (1979a).

Increased effectiveness in the utilization and analysis of dietary data can also be accomplished by reducing the data using a conceptual framework that differs from the traditional determination of "average daily nutrient quantities consumed." A simple but meaningful way of reducing food consumption data is to compute the nutrient density of diets. The nutrient density of a food, or food combination in a meal, is defined as the ratio of the nutrient composition of the food, food combination or diet, to the calorie contribution (Wyse et al., 1976). Determination of the nutrient density of food consumed provides a measure of the nutritional quality of diets. Analysis of food consumption data utilizing this concept can be used to demonstrate similarities and differences in the quality of diets among individuals or groups.

Blix (1965) utilized the nutrient density concept when examining the relation between total calories and selected nutrients obtained from consumption values reported in three surveys of food consumption in Sweden. With one exception (vitamin C) the intake of nutrients was found to be roughly proportional to the calories supplied. The author concluded that the food consumed was qualitatively about the same for all population groups studied, with some eating more and some eating less of the same basic diet. Wretlind (1977) attributed this to the fact that in a homogeneous population like the Swedish one, a dietary tradition is formed such that dietary habits of different groups are remarkably similar.

It is unlikely that the U.S. population would be classified as homogeneous, yet substantial efforts have been made by the government to provide the majority of the population equitable access to the same food supply. A recent nutrient density analysis of NFCS dietary data of selected sex-age groups indicated that, with the exception of vitamins A and C, there was a marked qualitative consistency of food consumed by the U.S. population despite wide variations in total calories consumed (Windham et al., 1981). Americans appeared to be eating from a "common table," each according to his own needs.

The basic need of any individual is for energy (Hansen, 1973). For proper maintenance of body weight, the intake of energy in the form of calories must be within a rather narrow range. Other nutrient requirements must be contained within this framework of energy need, if a diet is to be considered well-balanced or nutritionally adequate (Sorenson et al., 1976; Wyse et al., 1976). The general sedentary lifestyle in the U.S. makes it necessary that Americans carefully balance nutrient and energy intakes so that nutritionally adequate diets are consumed (Wyse et al., 1980). Utilizing the nutrient density concept to analyze diets of NFCS participants provides a means of determining the extent to which nutrient to calorie balance occurs among different population groups.

Measures for assessing quality of foods have been developed and used in nutrition and food intake studies over the years. The simplest method is comparison of food consumption with recommended amount of the standard "basic four" or "basic four plus one" food groups (USDA, 1980a). Food intake may also be calculated in terms of specific nutrients using food composition data and then compared with the Recommended Dietary Allowances (RDA). In previous food consumption survey reports, the USDA used the terms "poor", "fair" and "good" to indicate the total number of nutrients for which household intake met or exceeded a so-called critical level of 67 percent of the RDA. Dietary scores such as nutrient adequacy ratios (NAR) and mean adequacy ratios (MAR) have also been developed to provide rapid evaluation of dietary adequacy (Guthrie and Scheer, 1981).

Recently the Index of Nutritional Quality (INQ) was developed as a quantitative measure of describing diet quality (Hansen, 1973). The INQ compares the nutritive content of a quantity of a specific food, food combination or diet, with its energy content in terms of a standard allowance for the various nutrients and energy. The standard usually used to calculate the INQ is the RDA of the Food and Nutrition Board. However, any nutrition standard can be applied, such as the U.S. RDA for nutrition labeling, international standards, such as those recommended by the Food and Agricultural Organization (FAO), or arbitrarily defined standards were current standards do not exist, as for carbohydrate, fat and cholesterol.

It is important that valid standards be used in the interpretation of survey data (Sabry, 1977). Because nutrient consumption research in the U.S. has focused upon determining estimates of average quantities of energy and nutrients consumed by various sex-age groups, the standards used for comparison have been the Recommended Dietary Allowances. The RDA are expressed separately for males and females because of differences in their assumed physiologic states, growth rates, ages at maturation and muscle mass characteristics (Hansen and Wyse, 1980). The distinctions among dietary allowances for males, females, the different age groups and pregnancy and lactation are important for use by nutrition professionals such as the dietitian and clinician (Hansen et al., 1978).

The variations in nutrient allowances for the different ages and sexes have little importance in feeding groups of mixed age and sex (Hegsted, 1975) or in evaluating the dietary adequacy of mixed groups. An alternative type of dietary standard would be more effective for these purposes. Using the standard RDA, Hansen and Wyse (1980) derived standard nutrient allowances per 1000 kilocalories and demonstrated their usefulness in evaluating adequacy of food consumption, educating the public, and developing national policies concerning nutrition labeling and fortification.

Expressing both dietary allowances and nutrient composition of food or diets on a nutrient density basis provides a means for assessing the nutritional quality of foods consumed. Diets of population groups can be examined and compared with respect to their ability to meet dietary allowances relative to the calories provided, regardless of the sex and age distribution of the individuals composing the group.

The quantitative evaluation of a food or diet can be determined by the INQ value assigned to the various nutrients using the formula:

$$\text{INQ} = \frac{\text{Amount of nutrient in 1000 kcal}}{\text{Human allowance of that nutrient per 1000 kcal}}$$

An INQ value greater than 1.0 for a nutrient indicates that an amount of a particular food or combination of foods that would satisfy the total energy requirement would also provide a sufficient amount of the nutrient. Conversely, INQ values less than 1.0 would identify nutrients in foods of which an excess, in terms of calories, must be consumed to meet the recommended allowances for those nutrients (Wyse et al., 1976).

Sorenson et al. (1976) described the application of INQ approach to nutritionally analyze cycle menus in institutions and its use to aid in planning clinical menus to fit a patients' special dietary needs. Similarly, Wyse et al. (1976) showed how diets of various population groups can be evaluated to identify their nutrient needs. Windham et al. (1981) used this approach to identify qualitative patterns of food consumption of sex-age groups, as well as indicating the degree to which the population meets the RDA. Other uses of the INQ concept have been to apply it to analysis of fad reducing diets, groups of foods, snack foods, vending machine items, vegetarian diets and nutrition education (Sorenson and Hansen, 1975; Wyse et al., 1976; Wittwer et al., 1977; Hansen and Wyse, 1979; Brown et al., 1979).

A study to determine the effect of household characteristics on the nutritional quality of diets was conducted using the INQ and a multiple regression model (Abdel-Ghany, 1978). The INQ for each nutrient consumed per household were the dependent variables and selected household characteristics including income, size, race and nutrition knowledge of the homemaker were the independent variables. The results of this study indicated that income had no effect upon the

INQ of the selected nutrients. This suggested to the author that there may have been efficient substitution of good quality, less costly foods in the diets of low-income households.

Comparing the results of this study with the findings of Adrian and Daniel (1976) emphasizes the usefulness of the nutrient density concept for dietary evaluation. Adrian and Daniel found that income had a significant effect upon nutrient consumption of households when expressed as average daily quantities consumed. Abdel-Ghany found no effect of income on the nutritional quality of household diets using the INQ measure and similar statistical analysis. Acknowledgedly, some of the independent variables in these two studies differed and the samples studied were not identical; however, comparison of the results provides some interesting insights. It appears that adequate quantity of food, not quality, diminishes with income and low-income households have succeeded in selecting efficient dietaries in terms of nutrients to calorie ratios. Thus, using nutrient density analysis does provide additional information regarding household food consumption. Other measures indicate the degree to which food consumed meets specific level of nutrient intakes. The INQ as a supporting measure also indicates the degree of balance of the different nutrients in the diet.

The USDA has emphasized that scientific and technical research must be the basis for effective nutritional surveillance and for developing future nutrition policy and program strategies (USDA, 1979a). Central to achieving these goals is assessment of the current status of food consumption practices through evaluation of nutrient intake and nutritional quality of diets consumed by the population. Nutrient density analysis and progressive statistical techniques can make the evaluation of food consumption survey data more informative, efficient and timely.

METHODOLOGY

Restatement of the Objectives

The purpose of this study was to evaluate the nutrient density concept for analysis of food consumption survey data. Nutrient density analysis was used to specify relationships between socioeconomic characteristics of population groups and the nutrient densities of their diets. Comparisons were made of average nutrient densities of diets with standard allowances per 1000 kilocalories to obtain a measure of the nutritional quality of diets. The contribution of nutrient-dense and calorie-dense foods to the diets of selected population groups was also determined.

Research Design

The research study was designed to utilize and evaluate a number of techniques for assessing the nutritional quality of diets from survey data. A theoretical model was developed using demographic, sociological and economic concepts to explain variations in the nutrient densities of individual diets. A probabilistic approach was used to test the appropriateness of the theoretical model. Comparative and descriptive analyses were used to evaluate the nutritional quality of group diets relative to standards of quality and to describe nutrient density consumption patterns in terms of nutrient-dense and calorie-dense foods.

Theoretical Framework

Economic, sociological and demographic factors have been shown to have an influence on the consumption of food and nutrients. In this study, selected demographic and socioeconomic factors were merged into a theoretical model to explain similarities and differences in the nutrient densities of diets of different population groups. The socioeconomic model was specified as:

$$Qij = f\ (I,G,U,N,R,M,F,E,D)$$

where Qij = the quantity of the ith nutrient ($i = 1, \ldots, 14$) consumed per 1000 kilocalories of food reported as consumed from selected food groups and all sources by the jth individual, with

$i = 1$ = protein

$i = 2$ = fat

$i = 3$ = carbohydrate

$i = 4$ = calcium

$i = 5$ = iron

$i = 6$ = magnesium

$i = 7$ = phosphorus

$i = 8$ = vitamin A

$i = 9$ = thiamin

$i = 10$ = riboflavin

$i = 11$ = preformed niacin

$i = 12$ = vitamin B_6

$i = 13$ = vitamin B_{12}

$i = 14$ = vitamin C

I = annual income of the household

G = geographic location (region) of the household

U = degree of urbanization of the place of residence

N = number of members in the household

R = race or ethnicity of the individual

M = employment status of the male head of the household

F = employment status of the female head of the household

E = educational attainment of the male head of the household

D = educational attainment of the female head of the household

All nutrients are constituent parts of food and, theoretically, the consumption of each nutrient is affected by the same factors. Although each nutrient may be affected differently by the various factors, there were no justifiable reasons to include or delete a variable for any one nutrient estimate. Thus, a consumption relationship was specified using the same socioeconomic model for each nutrient.

Socioeconomic Concepts

The relationships of economic, sociological and demographic factors to the nutrient densities of diets have not been adequately defined. Consumers purchase the respective nutrients indirectly through their allocation of dollars to various food products. In allocating income to food items consumers are assumed to be making decisions which reflect their desire to have and maintain a balanced and adequate diet yet many people are unaware of the nutritional quality of different food products or of their diets in general. Also, some food purchases and consumption practices are based upon non-nutritive criteria such as habit, preferences, availability, cultural or social customs and practices and other situational factors. The nutrient density analysis approach can improve understanding of consumption patterns by specifying the relation of economic and sociological factors to nutrient density of diets.

Income. It is well-known that dietary status is affected by the ability to procure and utilize foods. Since procurement usually involves purchase, the level of income is frequently used as a measure to explain differences in the dietary status of people. Individuals, families or households are assumed to allocate available income among many alternative and competing goods and services so as to maximize satisfaction. The availability of income influences the nature of the food mix that is purchased and thus, the respective quantities of nutrients consumed. It is assumed that anyone who has adequate money, food stamps or commodities should be able to eat well. However, possession of sufficient income, food stamps, or even food, does not necessarily ensure that an individual will eat well or properly from a nutritional point of view. It is rather an opportunity to eat well that monetary and food possessions give to an individual or family.

At low income levels, consumption of goods and services is more constrained than at high income levels. Increases in income have been shown to be positvely related to the total consumption of most nutrients (Adrian and Daniel, 1976) but not related to the nutritional quality of diets (Abel-Ghany, 1978). In this study, income was hypothesized to have a positive effect upon food energy consumption, but no impact upon the nutrient density of diets.

Geographic area. Different geographic locations vary in terms of climate, topography and natural resource availability. These variations are often reflected in the economic, social, cultural and demographic development of a region with respect to such factors as occupational opportunities, increasing urbanization, standards of living, and regional food types and price variations. Geographic location, to the extent that it reflects these factors, could have an impact upon food consumption patterns. For this study, inferences were limited regarding regional effects upon nutrient densities of diets because there was no well defined, *a priori*, information concerning these relationships.

Urbanization. Degree of urbanization is a factor which can reflect the influence of several variables. Some of these are the potential for home food production, accessibility of diverse types of stores providing wide variety of foods, occupational and educational opportunities, and effects of mass media and information availability. Food price variations and buying power may also be reflected in this variable. There may be significant differences in the buying power of the same amount of money between small towns in non-metropolitan, agricultural areas and large cities in metropolitan industrial areas. The effect that degree of urbanization may have on nutrient densities of diets could not be estimated; therefore, *a priori* hypotheses were not established regarding these relationships.

Household size. Generally, a household should increase consumption of all nutrients as family size increases in order to maintain a relative nutrient balance. If food consumption per household does not increase with an increase in family size, the available nutrients would have to be reallocated among all family members. If food consumption per household does increase with increasing family size, any changes in the nutrient density of diets of individual family members depends upon the nutrient density of the additional food supply and the allocation of food among household members.

Race. Different racial groups often have differing ethnic and cultural customs and practices which can influence their food consumption patterns and thus, the nutrient densities of their diets. Race and ethnic background also have much to do with social stratification in the United States. The color of a person's skin or the possession of distinctive cultural traits have often been grounds for differential treatment in the assignment of social class. The isolation of racial or ethnic influence on nutritional quality of diets is complicated by possible interrelationships with other social and economic factors. Therefore, *a priori* hypotheses concerning the impact of race on nutrient density of diets were not ascertained.

Employment status of household heads. The employment status of the male and female heads of households obviously affects available income and thus, indirectly, total food consumption. Employment status, particularly of the female head, may also affect the nutritional quality of diets of household members. In addition to effects which would be reflected through variations in income, female employment outside the home could limit the amount of time available for planning, selecting and preparing food for consumption. The purchase and consumption of more "convenience" foods might be expected by individuals residing in households with an employed female head. The precise impact of these relationships on the nutrient density of diets was not hypothesized because little information was available regarding use and quality of convenience foods or other results of the female being employed outside the home.

Educational attainment of household heads. The level of education achieved by the male and female heads of the household was hypothesized to have a positive effect upon the nutritional quality of diets. Educational achievement generally reflects the ability, knowledge and resourcefulness of the individual and also aspirations which may be applied to all family members. The attainment of education should, theoretically, increase nutritional knowledge and understanding of nutrition related concepts. Therefore, an increase in the educational level of the heads of the household should result in quality diets for all household members.

Statistical Model

Multiple linear regression analysis was one technique used to analyze the relationships suggested in the theoretical model. This statistical method allowed determination of the effect of the set of demographic and socioeconomic factors simultaneously on the nutrient densities of individual diets. Thus, this technique permitted isolation of the impacts of several factors which theoretically contributed to a single result, i.e., nutritional quality of food consumed.

The regression approach to this problem required definition of dummy or indicator variables to incorporate the demographic and socioeconomic information as qualitative factors in the regression model. Each factor was subdivided into categories or levels which were represented in the model by indicator variables using the usual constraints (1, 0, -1) format. The indicator variable approach required definition of one less dummy variable than the number of treaments in each factor, with the condition that the sum of the dummy variable coefficients equal zero. This approach is necessary to avoid the problem of singularity in the X'X matrix.

Statistical significance of each level within a factor was measured relative to the overall mean for the factor. Signs and magnitude of the factor level coefficients reflected the relative direction and impact of each class on the dependent variable, nutrient density. The effect of the set of all levels within a factor, or the total factor effect, was determined using subset analysis. Statistical significance was measured using the F test.

Nutritional Quality of Diets

The nutrient density consumption relationships which were suggested in the theoretical model were used as a basis for comparing nutritional quality of group diets with nutrient density standards. Groups were identified by the same demographic and socioeconomic characteristics included in the theoretical model. The standards used to evalute the nutritional quality of foods consumed were nutrient allowances per 1000 kilocalories (Hansen and Wyse, 1980). The use of these standards precluded the need to further subdivide the selected groups into age and sex categories, a process necessary when using the Recommended Dietary Allowances (Food and Nutrition Board, 1980a).

Contribution of Nutrient-Dense and Calorie-Dense Foods

The nutrient density concept was applied in this analysis to determine the nutrient contribution of calorie-dense and nutrient-dense foods to the diets of population groups specified in the theoretical model. Calorie-dense foods were defined as those included in the Fats-Sweets-Alcohol group. Foods from the other four food groups were defined to be nutrient-dense foods. Relationships were determined between the proportion of dietary nutrients derived from these two broad food groupings and demographic and socioeconomic factors which were found, by the statistical analysis, to have a significant effect upon nutrient density of diets.

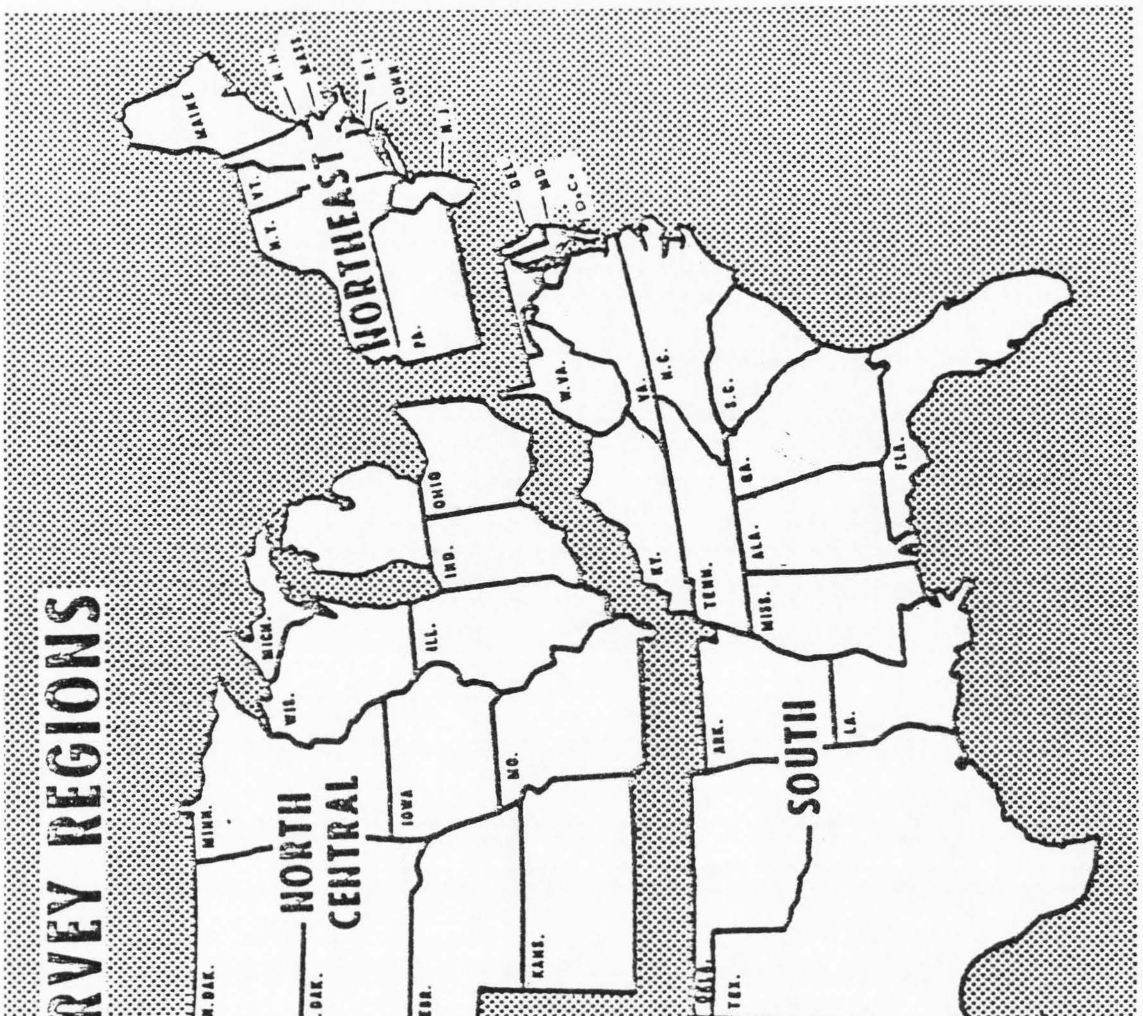
Description of the Survey

National and regional surveys can be expensive in terms of economic and other resources, thus, extensive use of available national and regional data to analyze relevant problems is imperative. This study was based upon data collected in the USDA Nationwide Food Consumption Survey, 1977-1978. This is the sixth nationwide survey conducted by the Department of Agriculture since 1936. It is the second to include households in all four seasons of the year and to obtain nationwide information on diets of selected individual household members as well as food consumption levels for the total household. This survey provides detailed information on food used by household, food consumed by individuals and computed estimates of the nutrient content of these foods. The survey also provides data on demographic, sociologic and economic factors that might affect food consumption.

From April 1977 to March 1978, a stratified probability sample of households was surveyed. Information was obtained from approximately 15,000 households in the 48 contiguous states and about 34,000 individuals from these households. Approximately 3500 households and 8600 individuals residing in these households were surveyed in the spring (April, May, June) of 1977. Individuals residing in institutions, on military bases or in rooming or boarding houses were not included. Households were selected to adequately represent consumption patterns in metropolitan, surburban and non-metropolitan areas in each of four census regions in the United States (Figure 1).

The original data were collected by personal interview with household members. A household repondent, usually the homemaker, supplied information on household characteristics such as income, participation in food programs, and educational attainment and employment status of the heads of the households. Information was then collected on the kinds and quantities of food used by the households during the seven days preceding the interview. This information comprised the "household" portion of the survey. After household food consumption information was obtained, the interviewer also obtained, from each eligible household member present, a record

Figure 1. Geographical regions of the U.S.D.A. Nationwide Food Consumption Survey (USDA, 1969a).


SURVEY REGIONS
NORTHEAST
NORTH CENTRAL
SOUTH
WEST
MAINE
N.H.
MASS
R.I.
CONN
N.J.
N.Y.
VT.
PA.
DEL.
MD.
D.C.
W.VA.
VA.
N.C.
S.C.
GA.
FLA.
ALA.
MISS.
TENN.
KY.
OHIO
IND.
ILL.
MICH.
WIS.
MINN.
IOWA
MO.
ARK.
LA.
N.DAK.
S.DAK.
NEBR.
KANS.
OKLA.
TEX.
MONT.
WYO.
COLO.
N.MEX.
IDAHO
UTAH
ARIZ.
WASH.
OREG.
NEV.
CALIF.

of the previous day's dietary intake. Individuals then recorded their intake for the day of the interview and the following day and thus provided data for three consecutive days. The household respondent usually answered for children under 12 years of age and others unable to answer for themselves. This information comprised the "individual" segment of the survey.

Description of the Subjects

This study utilizes data from the Spring portion of the individual survey of approximately 8600 individuals. Approximately 375 individuals (4%) were eliminated from the original survey to form the sample utilized for this analysis. Observations were excluded because data elements were missing or miscoded or because the household was not a housekeeping household or an economic unit. A housekeeping household was defined by USDA (1980c) as having at least one person in the household who consumed at least 10 meals from the household food supply in the seven days preceding the survey interview. An economic unit was defined as a household which made expeditures from a common pool of income. Food intake data were not reported for all three days by all participants in the survey. This study utilized data on the nutritive value of foods reported as consumed by individuals, ages four years and older, for whom at least two days of food intake were reported.

After adjusting the original sample for all of these occurences, 7285 individuals were included in the sample for this study. The Northeast, North Central, South and West regions had 1626, 1993, 2535 and 1131 observations, respectively. Distribution of these individuals among respective urbanization, income, household size, race, employment and education categories are listed in Tables 1 and 2.

Description of the Procedures

The objectives of this study involved the specification of the nutrient densities of diets consumed by individual household members in the survey sample. For each individual the average daily amounts of nutrients consumed per 1000 kilocalories of food consumed were computed from the nutritive value data previously compiled by USDA. Values per 1000 kilocalories were determined for protein, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, preformed niacin, vitamin B_6, vitamin B_{12} and vitamin C.

Specification of the Statistical Model

Multiple linear regression analysis was used to estimate the effects of demographic and socioeconomic factors on individual nutrient consumption per 1000 kilocalories. The following statistical model was developed from relationships suggested by the theoretical model:

$$\begin{aligned} Q_{ij} = {} & a + b_1H + b_2W + b_3U_1 + b_4U_2 + b_5G_1 + \ldots + \\ & b_7G_3 + b_8A_1 + \ldots + b_{14}A_7 + b_{15}S + b_{16}R_1 + \\ & \ldots + b_{18}R_3 + b_{19}I_1 + \ldots + b_{25}I_7 + b_{26}N_1 + \ldots + \\ & b_{28}N_3 + b_{29}M_1 + b_{30}M_2 + b_{31}E_1 + \ldots + b_{33}E_3 \\ & + b_{34}F_1 + b_{35}F_2 + b_{36}D_1 + \ldots b_{38}D_3 + \\ & b_{39}SA_1 + \ldots + b_{45}SA_7 + b_{46}U_1R_1 + \ldots + \end{aligned}$$

Table 1. Distribution of individuals in the sample by urbanization, income, household size and race categories, the United States and regions of the United States, Spring 1977.

Category	United States	North-east	North Central	South	West
Total	7285	1626	1993	2535	1131
Urbanization:					
Central City	1887 (.25)*	408 (.25)	478 (.24)	667 (.26)	334 (.30)
Suburban	2655 (.36)	739 (.45)	680 (.34)	728 (.29)	508 (.45)
Non-Metro	2743 (.38)	479 (.29)	835 (.42)	1140 (.45)	289 (.26)
Income:					
Under $5,000	704 (.10)	136 (.08)	140 (.07)	344 (.14)	84 (.07)
$ 5,000 - 9,999	1142 (.16)	236 (.15)	221 (.11)	503 (.20)	182 (.16)
$10,000 - 14,999	1206 (.17)	217 (.13)	328 (.16)	434 (.17)	227 (.20)
$15,000 - 19,999	1070 (.15)	261 (.16)	320 (.16)	330 (.13)	159 (.14)
$20,000 - 24,999	727 (.10)	179 (.11)	232 (.12)	200 (.08)	116 (.10)
$25,000 - 39,999	825 (.11)	241 (.15)	241 (.12)	177 (.07)	166 (.15)
$40,000 or more	204 (.03)	27 (.02)	89 (.04)	27 (.01)	61 (.05)
not reported	1407 (.19)	329 (.20)	422 (.21)	520 (.21)	136 (.12)
Household size:					
1 member	438 (.06)	104 (.06)	113 (.06)	149 (.06)	72 (.06)
2 members	1575 (.22)	369 (.23)	413 (.21)	524 (.21)	269 (.24)
3-4 members	2750 (.38)	612 (.38)	698 (.35)	1014 (.40)	426 (.38)
>5 members	2522 (.35)	541 (.33)	769 (.39)	848 (.33)	364 (.32)
Race/Ethnicity:					
White	6191 (.85)	1459 (.90)	1825 (.92)	1917 (.76)	990 (.88)
Black	849 (.12)	115 (.07)	127 (.06)	545 (.21)	62 (.05)
Spanish	128 (.02)	38 (.02)	4 (.00)	48 (.02)	38 (.03)
Other	117 (.02)	14 (.01)	37 (.02)	25 (.01)	41 (.04)

*Numbers in parentheses are proportion of individuals in each category.

Table 2. Distribution of individuals by education level and employment status of male and female heads of households, United States and regions of the United States, Spring 1977.

Category	United States	North-east	North Central	South	West
Total	7285	1626	1993	2535	1131
Employment Status:					
Male Head					
Employed	4972 (.68)*	1104 (.68)	1443 (.72)	1625 (.64)	800 (.71)
Not Employed	1191 (.16)	257 (.16)	306 (.15)	461 (.18)	167 (.15)
Unknown, Not Reported	1122 (.15)	265 (.16)	244 (.12)	449 (.18)	164 (.14)
Female Head					
Employed	2873 (.39)	655 (.40)	841 (.42)	894 (.35)	483 (.43)
Not Employed	4233 (.58)	934 (.57)	1115 (.56)	1566 (.62)	618 (.55)
Unknown, Not Reported	179 (.02)	37 (.03)	37 (.02)	75 (.03)	30 (.03)
Education Level:					
Male Head					
Elementary or less	1004 (.14)	173 (.11)	270 (.14)	478 (.19)	83 (.07)
At least some high school	2928 (.40)	587 (.36)	851 (.43)	1031 (.41)	459 (.41)
At least some college	2216 (.30)	588 (.36)	629 (.32)	574 (.23)	425 (.38)
Unknown, not reported	1137 (.16)	278 (.17)	243 (.12)	452 (.18)	164 (.15)
Female Head					
Elementary or less	946 (.13)	158 (.10)	188 (.09)	502 (.20)	98 (.09)
At least some high school	4011 (.55)	871 (.54)	1173 (.59)	1407 (.56)	560 (.50)
At least some college	2122 (.29)	557 (.34)	588 (.30)	534 (.21)	443 (.39)
Unknown, not reported	206 (.03)	40 (.02)	44 (.02)	92 (.04)	30 (.03)

*Numbers in parentheses are the proportion of individuals in each category.

$$b_{48}U_1R_3 + b_{49}U_2R_1 + \ldots + b_{51}U_2R_3 +$$
$$+ b_{52}N_1I_1 + \ldots + b_{58}N_1I_7$$
$$+ b_{59}N_2I_1 + \ldots + b_{65}N_2I_7 + b_{66}N_3I_1$$
$$+ \ldots + b_{72}N_3I_7$$

The dependent variables (Q_{ij}'s), or average daily quantities of nutrients consumed per 1000 kilocalories consumed by the jth individual (j = 1 to 7285), were specified as follows:

Q_1 = average daily kilocalories (kcal) of food energy consumed for the sample;

Q_2 = average daily grams (gm) of protein consumed per 1000 kilocalories consumed for the sample;

Q_3 = average daily grams (gm) of fat consumed per 1000 kilocalories consumed for the sample;

Q_4 = average daily grams (gm) of carbohydrate consumed per 1000 kilocalories consumed for the sample;

Q_5 = average daily milligrams (mg) of calcium consumed per 1000 kilocalories consumed for the sample;

Q_6 = average daily milligrams (mg) of iron consumed per 1000 kilocalories consumed for the sample;

Q_7 = average daily milligrams (mg) of magnesium consumed per 1000 kilocalories consumed for the sample;

Q_8 = average daily milligrams (mg) of phosphorus consumed per 1000 kilocalories consumed for the sample;

Q_9 = average daily international units (I.U.) of vitamin A consumed per 1000 kilocalories consumed for the sample;

Q_{10} = average daily milligrams (mg) of thiamin consumed per 1000 kilocalories consumed for the sample;

Q_{11} = average daily milligrams (mg) of riboflavin consumed per 1000 kilocalories consumed for the sample;

Q_{12} = average daily milligrams (mg) of preformed niacin consumed per 1000 kilocalories consumed for the sample;

Q_{13} = average daily milligrams (mg) of vitamin B_6 consumed per 1000 kilocalories consumed for the sample;

Q_{14} = average daily micrograms (μg) of vitamin B_{12} consumed per 1000 kilocalories consumed for the sample;

Q_{15} = average daily milligrams of vitamin C consumed per 1000 kilocalories consumed for the sample.

The independent variables were coded using usual constraints (1, 0, -1 dummy variables) techniques of analysis of covariance in a general linear model. Independent variables were defined as follows:

U_1 to U_2 = degree of urbanization of the place of residence;

G_1 to G_3 = geographic location of the place of residence;

R_1 to R_3 = race or ethnic origin of the individual;

I_1 to I_7 = total annual income of the household;

N_1 to N_3 = number of individuals residing in the household;

M_1 to M_2 and F_1 to F_2 = employment status of the male (M) and female (F) heads of the household during the week preceding the survey interview;

E_1 to E_3 and D_1 to D_3 = level of education attained by the male (E) and female (D) heads of the household;

H = height in inches of the individual;

W = weight in pounds of the individual;

S = gender of the individual;

A_1 to A_7 = age in years of the individual.

Degree of urbanization was classified into central city, suburban (metro), and non-metropolitan. Geographic regions were northeast, north central, south and west (Figure 1). Households were classified into one of four race or ethnic groups: white, black, Spanish and other. Annual household income was divided into seven classes: less than \$5,000, \$5,000 - 9,999, \$10,000 - 14,999, \$15,000 - 19,999, \$20,000 - 24,999, \$25,000 or more, and not reported. Household size was classified into four categories representing 1 member, 2 members, 3 to 4 members or 5 or more members. Categories for employment status of the male and female heads were: employed, not employed, and not reported. The four education levels were: elementary school or less, at least some high school, at least some college, and not reported. The indicator variable coding scheme is presented in Appendix A. Two-way interaction variables were entered into the model for the region by urbanization and income by household size interactions. This provided a test of the differential influence of region and household size depending upon the degree of urbanization and income levels, respectively, of the household in which individuals resided.

The age, sex, height and weight of individuals were entered as control variables into the regression model in order to control for variations in nutrient density of diets which might otherwise be attributable to differences within these factors. Sex and age were entered as categorical variables. Sex categories were male and female. Age classifications were: four to six years, seven to ten years, 11 to 14 years, 15 to 18 years, 19 to 22 years, 23 to 50 years, 51 to 64 years, and 65 or more years. Variables were also included to control for the sex by age interaction effect. Heights and weights were entered as continuous variables or covariates.

Nutritional Quality Determination

Data on the demographic and socioeconomic characteristics were used to classify survey participants into population subgroups on the basis of geographic region and degree of urbanization of the place of residence, annual household income, household size, race or ethnicity, employment status of the male and female heads of the household educational attainment of the male and female heads of the household, and sex and age of the individual. For each group, the average nutrient density of diets were determined for fourteen nutrients: protein, fat, carbohydrate, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, preformed niacin, vitamin B_6, vitamin B_{12} and vitamin C. The means were computed as part of the multiple regression analysis and represent average nutrient consumption for the groups adjusted for the effects of other variables in the model. The statistical test results from the multiple regression analysis also apply to the analysis of these data. If a variable (socioeconomic factor) was judged to be significant by the F test in the regression equation, multiple comparisons were made to determine which groups within the factor were different. Fisher's Least Significant Difference (LSD) procedure was utilized to make all pairwise comparisons between the means within each factor. Two means were judged to be significantly different if the absolute value of their difference exceeded

$$LSD = t_{\alpha/2,v}\sqrt{MSE\left(\frac{1}{n_i} + \frac{1}{n_j}\right)}$$

where MSE is the mean square error for the experiment based upon v degrees of freedom, $t_{\alpha/2}$ is the critical value of the Student's t distribution for comparing two population means at alpha = 0.01 and n_i, n_j are the number of observations in the ith and jth groups, respectively.

Mean nutrient consumption per 1000 kilocalories for significantly different groups was compared with the single value nutrient allowances per 1000 kilocalories listed in Table 3. This comparison provided an Index of Nutritional Quality (INQ) for each nutrient for each population sub-group. Comparisons were made of similarities and differences in the INQ values of the selected population groups.

Nutrient Contribution of Food Groups

Foods, reported as consumed by survey participants, were classified into nutrient-dense and calorie-dense categories. The average daily intake of kilocalories and 14 nutrients from these two categories were computed using the nutritive value data. The average daily nutrient intake from all sources and the percent of total nutrient intake from nutrient-dense and calorie-dense foods were calculated for each individual. Subgroups were formed on the basis of the same demographic and socioeconomic characteristics as in the previous analyses. The average percent contribution of each nutrient from the two food-groupings were computed for those population groups which had significantly different nutrient density consumption based

Table 3. Single-value nutrient allowances per 1,000 kilocalories.

Nutrient	Amount
protein	25 gm.
fat	39 gm.
carbohydrate	137.5 gm.
calcium	450 mg.
iron	8 mg.
magnesium	150 mg.
phosphorus	450 mg.
vitamin A	2,000 I.U.
thiamin	0.5 mg.
riboflavin	0.6 mg.
niacin	7.0 mg.
vitamin B_6	1.0 mg.
vitamin B_{12}	1.5 mg.
vitamin C	30 mg.

upon the statistical analysis.

The nutrient density and INQ of foods consumed from the nutrient-dense and calorie-dense groups were also computed for each individual and population sub-group. Comparisons were made among the selected population groups of the percent contribution of nutrients from the two food groupings and of the nutrient density of foods consumed from nutrient-dense and calorie-dense groups.

Data Processing and Analysis

Computer tapes containing all the original dietary, nutritive value, demographic and socioeconomic data collected in the 1977-1978 Nationwide Food Consumption Survey were obtained from the Consumer Nutrition Center, Human Nutrition, U.S. Department of Agriculture. Appropriate data files were compiled for each segment of this study.

All data were analyzed using standard least squares regression programs available at Utah State University. Multiple regression analysis techniques were used to adjust nutrient density of diets for the independent variables geographic region, urbanization, income, race, household size, employment status and educational attainment of household heads. The regression model gave estimates of and significance levels of the linear coefficients for each factor level and subset. The F test was used to determine if there were differences in nutrient density consumption patterns for the total effect of each factor specified in the model. Independent variables were judged at the 0.01 and 0.001 significance levels to determine which socioeconomic factors affected nutrient density consumption.

Adjusted means were computed for each nutrient for each population subgroup in the nutritional quality analysis and the food-group contribution analysis. The same statistical test results applied to the interpretation of data from these analyses.

RESULTS

The diversity and complexity of demographic, economic and sociological factors affecting food consumption behavior make the study of nutrient intake difficult. Previous research concerning the relationships between socioeconomic status of the individual and daily nutrient consumption has provided some insights into which population groups may be most vulnerable to inadequate nutrient intakes. Alternative approaches to the analysis of food consumption survey data are needed in order to obtain a more comprehensive description and understanding of nutrient consumption patterns of population groups in the United States.

Results

Nutrient Density Consumption Model

The socioeconomic characteristics of households or of household members which significantly affected the nutrient density of individual diets are indicated in Table 4. Mean square errors and significance levels for each factor are presented in an analysis of covariance table in Appendix B. Estimated regression coefficients and standard errors are listed in Tables 5 to 8 for each nutrient at each factor level.

The regression coefficients in Tables 5-8 are presented as average deviations in nutrient density consumption of each factor level from the estimated overall or national mean nutrient consumption per 1000 kcal. Deviation effects are presented for all factor level categories with the direction of the sign and the magnitude of the

Table 4. Significant relationships between socioeconomic factors, interaction effects and average daily intake of kilocalories and nutrients per 1000 kcal, United States, Spring, 1977.

Variable	Kilo-calories	Pro/ 1000 kcal	Fat/ 1000 kcal	CHO/ 1000 kcal	Ca/ 1000 kcal	Fe/ 1000 kcal	Mg/ 1000 kcal	P/ 1000 kcal	Vit. A/ 1000 kcal	Thia/ 1000 kcal	Ribo/ 1000 kcal	Niacin/ 1000 kcal	Vit. B_6/ 1000 kcal	Vit. B_{12}/ 1000 kcal	Vit. C 1000 kcal
Region					**										*
Urbanization												*	**		*
Income															
Household Size			*	*									**		*
Race/Ethnicity					*		**		*	**					
Employment Status Male Head	**			*			*								
Employment Status Female Head					*										
Education Level Male Head				*											
Education Level Female Head															*
Interaction Effects Region by Urbanization		*	*	*											
Income by Household Size												*			*

*Indicates statistical significance at $p \leq 0.01$.
**Indicates statistical significance at $p \leq 0.001$.
NOTE: Mean square errors and p values are reported in Appendix B.

Table 5. Estimates of consumption relationships between socioeconomic variables, average daily kilocalorie intake, and protein, fat and carbohydrate intakes per 1000 kcal, United States, Spring, 1977.

	Kilocalories		Protein		Fat		Carbohydrate	
Variables	deviation effect	standard error	deviation effect	standard error	deviation effect	standard error	deviation effect	standard error
Estimated Mean	1856.05 kcal		41.74 gm/1000 kcal		45.11 gm/1000 kcal		105.90 gm/1000 kcal	
Region								
Northeast	4.11	23.41	0.32	-0.37	-0.36	0.30	-0.92	0.83
North Central	-5.65	21.59	0.14	0.34	0.17	0.27	-0.45	0.77
South	-50.17	18.62	-0.26	0.29	-0.50	0.23	1.91	0.66
West	51.71	30.84	-0.20	0.49	0.69	0.39	-0.54	1.10
Urbanization								
Central City	-9.82	22.48	0.43	0.36	-0.17	0.28	-0.53	0.80
Suburban	-5.99	17.07	0.27	0.27	0.52	0.22	-1.40	0.61
Non-Metro	15.81	20.50	-0.70	0.32	-0.35	0.26	1.93	0.73
Income								
Under $5000	37.95	43.15	0.24	0.68	-0.03	0.83	0.83	1.54
$5,000-9,999	47,00	36.67	-0.52	0.58	0.19	0.46	1.82	1.31
$10,000-14,999	34.37	40.58	-0.78	0.64	-1.01	0.51	2.87	1.45
$15,000-19,999	106.84	66.80	-1.21	1.06	1.00	0.84	-5.78	2.38
$20,000-24,999	-92.76	83.51	1.68	1.32	-0.90	1.05	2.35	2.98
$25,000 +	-30.77	83.74	0.76	1.32	0.62	1.06	-3.89	2.98
Not reported	-102.63	36.16	-0.17	0.57	0.14	0.46	1.80	1.29
Household Size								
1 Member	40.00	89.71	-0.59	1.42	0.55*	1.13	-2.17*	3.20
2 Members	-20.47	30.41	1.15	0.48	0.82	0.38	-2.75	1.08
3-4 Members	8.98	17.88	-0.37	0.28	-0.15	0.23	1.62	0.64
5 +	-28.52	22.73	-0.19	0.36	-1.23	0.29	3.30	0.81
Race/Ethnicity								
White	82.16	6.02	-1.52	0.01	1.28	0.08	-1.47	0.21
Black	-9.65	39.15	0.53	0.62	0.40	0.49	-1.86	1.39
Spanish	-14.64	100.05	-0.31	1.58	-2.49	1.26	4.48	3.56
Other	-57.86	110.39	1.31	1.74	0.81	1.39	-1.16	3.93
Employment Status								
Male Head								
Employed	100.44**	35.90	1.31	0.57	2.60	0.45	-8.18*	1.28
Not Employed	-66.09	47.55	1.68	0.75	2.21	0.60	-7.30	1.69
Not Reported	-34.35	170.84	-2.99	2.70	-4.81	2.15	15.48	6.09
Female Head								
Employed	-131.36	17.38	0.19	0.27	0.22	0.22	0.36	0.62
Not Employed	-120.12	12.08	0.39	0.19	-0.47	0.15	2.46	0.43
Not Reported	251.47	185.45	-0.58	2.93	0.25	2.34	-2.82	6.61
Education Level								
Male Head								
Elementary	11.89	49.52	-1.04	0.78	-2.32	0.62	6.98*	1.76
High School	-12.37	38.08	-1.81	0.60	-1.58	0.48	6.24	1.36
College	25.45	41.19	-1.26	0.65	-1.55	0.52	5.78	1.47
Not Reported	-24.98	171.50	4.11	2.71	5:45	2.16	-19.00	6.11
Female Head								
Elementary	48.88	36.65	-0.20	0.58	0.23	0.46	0.41	1.31
High School	114.38	13.35	-0.31	0.21	0.26	0.17	0.01	0.48
College	84.66	24.28	-0.40	0.38	-0.36	0.31	1.60	0.86
Not Reported	-245.92	167.53	0.91	2.65	-0.12	2.11	-1.99	5.97

* $p \leq 0.01$
** $p \leq 0.001$

Table 6. Estimates of consumption relationships between socioeconomic variables and average daily calcium, iron, magnesium and phosphorus intakes per 1000 kcal, United States, Spring, 1977.

Variables	Calcium		Iron		Magnesium		Phosphorus	
	deviation effect	standard error	deviation effect	standard error	deviation effect	standard error	deviation effect	standard error
Estimated Mean	399.68 mg/1000 kcal		6.91 mg/1000 kcal		136.55 mg/1000 kcal		636.09 mg/1000 kcal	
Region								
Northeast	1.79**	6.05	-0.12	0.07	-0.12	1.38	0.97	5.15
North Central	6.11	5.58	0.00	0.06	0.68	1.27	3.56	4.75
South	-23.71	4.81	0.11	0.05	-3.66	1.10	-12.42	4.10
West	15.81	7.97	0.01	0.09	3.11	1.82	7.90	6.78
Urbanization								
Central City	0.90	5.81	0.08	0.06	0.50	1.33	4.09	4.94
Suburban	-4.04	4.41	0.06	0.05	0.62	1.01	-1.23	3.76
Non-Metro	3.14	5.30	-0.14	0.06	-1.12	1.21	-2.85	4.51
Income								
Under $5000	5.94	11.15	0.12	0.12	0.09	2.55	8.03	9.49
$5000-9,999	7.09	9.47	0.13	0.11	-1.88	2.16	3.12	8.07
$10,000-14,999	-9.74	10.48	-0.10	0.12	-0.62	2.40	-17.15	8.93
$15,000-19,999	-20.38	17.26	-0.46	0.19	-4.06	3.94	-7.98	14.69
$20,000-24,999	54.46	21.57	-0.12	0.24	10.85	4.93	46.97	18.37
$25,000 +	-35.56	21.63	0.20	0.24	-8.44	4.94	-27.87	18.42
Not Reported	-2.80	9.34	0.23	0.10	4.06	2.13	-5.13	7.95
Household Size								
1 Member	37.73	23.18	-0.18	0.26	10.91	5.29	27.42	19.73
2 Members	-14.35	7.86	0.27	0.09	-1.09	1.79	6.48	6.69
3-4 Members	-8.32	4.62	-0.06	0.05	-5.09	1.06	12.71	3.93
5 +	15.06	5.87	-0.03	0.07	-4.73	1.34	-21.18	5.00
Race/Ethnicity								
White	5.20*	1.56	-0.23	-0.02	3.55**	0.36	-0.89	1.32
Black	-31.19	10.11	-0.16	0.11	-7.68	2.31	-27.32	8.61
Spanish	-39.58	25.85	0.48	0.29	-0.61	5.90	0.44	22.01
Other	65.58	28.52	-0.10	0.32	4.75	6.51	27.76	24.28
Employment Status								
Male Head								
Employed	-5.78	9.27	0.02	0.10	-9.83*	2.12	-17.39	7.90
Not Employed	-6.50	12.28	0.09	0.14	-2.50	2.81	-7.33	10.46
Not Reported	12.28	44.13	-0.11	0.49	12.33	10.08	24.72	37.58
Female Head								
Employed	16.37*	4.49	0.02	0.05	-1.29	1.03	1.49	3.82
Not Employed	36.33	3.12	0.08	0.03	1.01	0.71	12.70	2.66
Not Reported	-52.69	47.91	-0.10	0.53	0.28	10.94	-14.19	40.79
Education Level								
Male Head								
Elementary	-5.72	12.80	0.09	0.14	3.53	2.92	7.68	10.89
High School	-2.90	9.84	-0.08	0.11	5.69	2.25	0.16	8.38
College	24.88	10.64	-0.22	0.12	7.65	2.43	20.03	9.06
Not Reported	-16.25	44.30	0.21	0.49	-16.86	10.12	-27.87	37.72
Female Head								
Elementary	-16.10	9.47	0.15	0.11	1.32	2.16	-4.99	8.06
High School	-12.26	3.45	-0.10	0.04	1.09	0.79	-7.28	2.94
College	15.01	6.27	-0.04	0.07	7.31	1.43	14.37	5.34
Not Reported	13.35	43.28	-0.01	0.48	-9.72	9.89	-2.10	36.85

$^{*}p \leq 0.01$
$^{**}p \leq 0.001$

Table 7. Estimates of consumption relationships between socioeconomic variables and average daily thiamin, riboflavin and niacin intakes per 1000 kcal, United States, Spring, 1977.

Variables	Thiamin deviation effect	Thiamin standard error	Riboflavin deviation effect	Riboflavin standard error	Niacin deviation effect	Niacin standard error
Estimated Mean	0.69 mg/1000 kcal		0.95 mg/1000 kcal		10.35 mg/1000 kcal	
Region						
Northeast	0.00	0.01	0.00	0.01	0.05	0.12
North Central	0.01	0.01	0.01	0.01	-0.05	0.11
South	0.01	0.01	-0.01	0.01	0.18	0.09
West	-0.02	0.01	0.00	0.02	-0.18	0.16
Urbanization						
Central City	0.01	0.01	0.02	0.01	0.27*	0.11
Suburban	0.01	0.01	0.00	0.01	0.10	0.09
Non-Metro	-0.01	0.01	-0.02	0.01	-0.36	0.10
Income						
Under $5000	0.00	0.01	0.02	0.03	0.09	0.22
$5000-9,999	0.02	0.01	0.02	0.02	-0.24	0.19
$10,000-14,999	-0.01	0.01	-0.03	0.02	-0.14	0.21
$15,000-19,999	-0.03	0.02	-0.04	0.04	-0.23	0.34
$20,000-24,999	0.02	0.03	0.06	0.05	0.24	0.42
$25,000 +	-0.01	0.03	-0.03	0.05	0.20	0.43
Not Reported	0.01	0.01	0.01	0.02	0.09	0.18
Household Size						
1 Member	0.01	0.03	0.05	0.05	0.06	0.46
2 Members	0.00	0.01	0.02	0.02	0.26	0.15
3-4 Members	-0.01	0.01	-0.01	-0.03	0.01	-0.09
5 +	0.00	0.01	-0.04	0.01	-0.07	0.12
Race/Ethnicity						
White	-0.05**	0.00	-0.01	0.00	-0.14	0.03
Black	0.00	0.01	-0.01	0.02	0.04	0.20
Spanish	0.04	0.03	-0.04	0.06	0.18	0.51
Other	0.01	0.03	0.06	0.07	-0.07	0.56
Employment Status						
Male Head						
Employed	-0.02	0.01	-0.02	0.02	-0.14	0.18
Not Employed	-0.02	0.02	-0.04	0.03	-0.01	0.24
Not Reported	0.04	0.06	0.06	0.10	0.15	0.87
Female Head						
Employed	-0.02	0.01	0.01	0.01	0.02	0.09
Not Employed	-0.01	0.00	0.04	0.01	-0.10	0.06
Not Reported	0.03	0.06	-0.05	0.11	0.08	0.94
Education Level						
Male Head						
Elementary	0.02	0.02	0.04	0.03	0.22	0.25
High School	0.00	0.01	0.00	0.02	-0.10	0.19
College	0.02	0.01	0.04	0.02	-0.12	0.02
Not Reported	-0.03	0.06	-0.07	0.10	0.00	0.87
Female Head						
Elementary	0.02	0.01	-0.01	0.02	-0.06	0.19
High School	0.01	0.00	0.00	0.01	0.04	0.01
College	0.02	0.01	0.03	0.01	0.07	0.12
Not Reported	-0.05	0.05	-0.03	0.10	-0.04	0.85

*p $\leq$ 0.01
**p $\leq$ 0.001

Table 8. Estimates of consumption relationships between socioeconomic variables and average daily vitamins B-6, B-12, Aand C intakes per 1000 kcal, United States, Spring, 1977.

	Vitamin B-6		Vitamin B-12		Vitamin A		Vitamin C	
Variables	deviation effect	standard error	deviation effect	standard error	deviation effect	standard error	deviation effect	standard error
Estimated Mean	0.79 mg/1000 kcal		2.95 µg/1000 kcal		3086.89 IU/1000 kcal		47.65 mg/1000 kcal	
Region								
Northeast	0.01	0.01	0.22	0.19	46.57	142.87	4.74*	1.35
North Central	-0.01	0.01	-0.11	0.18	-235.52	131.75	-2.05	1.24
South	0.00	0.01	-0.14	0.15	72.22	113.65	-2.67	1.07
West	-0.01	0.01	0.03	0.26	116.73	118.24	-0.02	1.78
Urbanization								
Central City	0.03**	0.01	0.20	0.19	274.61	137.17	1.28*	1.30
Suburban	0.01	0.01	0.15	0.14	59.97	104.19	2.15	0.98
Non-Metro	-0.03	0.01	-0.35	0.17	-334.58	125.10	-3.43	1.81
Income								
Under $5000	-0.01	0.02	0.51	0.36	95.56	263.36	-5.63	2.49
$5,000-9,999	-0.01	0.02	0.02	0.30	30.27	223.79	1.96	2.11
$10,000-14,999	-0.03	0.02	-0.04	0.34	-110.25	247.68	5.21	2.33
$15,000-19,999	-0.02	0.03	-0.34	0.56	-615.29	407.69	-6.25	3.85
$20,000-24,999	0.04	0.03	-0.51	0.69	172.31	509.63	2.31	4.81
$25,000 +	0.01	0.03	0.40	0.70	304.96	511.08	-0.25	4.83
Not Reported	0.01	0.02	-0.04	0.30	122.45	220.70	2.65	2.08
Household Size								
1 Member	0.05**	0.04	0.03	0.75	602.46	547.50	9.12*	5.17
2 Members	0.03	0.01	0.62	0.25	206.36	185.58	0.87	1.75
3-4 Members	-0.03	0.01	-0.22	0.15	-244.40	109.15	-3.41	1.03
5 +	-0.05	0.01	-0.43	0.19	-564.42	138.73	-6.57	1.31
Race/Ethnicity								
White	-0.02	0.00	-0.08	0.05	-304.07*	36.74	-2.23	0.35
Black	0.01	0.02	0.31	0.33	487.21	238.95	5.91	2.26
Spanish	0.05	0.04	-0.65	0.83	-1185.37	610.62	-1.52	5.77
Other	-0.04	0.05	0.42	0.92	1002.23	673.71	-2.15	6.36
Employment Status								
Male Head								
Employed	0.00	0.01	0.30	0.30	371.01	219.11	-3.87	2.07
Not Employed	0.00	0.02	-0.28	0.40	-78.85	290.21	-3.29	2.74
Not Reported	0.01	0.07	-0.02	1.42	-292.16	1042.61	7.16	9.85
Female Head								
Employed	0.00	0.01	0.06	0.14	104.42	106.09	2.33	1.00
Not Employed	-0.01	0.01	0.25	0.10	266.34	73.73	3.61	0.70
Not Reported	0.01	0.07	-0.31	1.54	-370.76	-1131.80	-5.94	10.69
Education Level								
Male Head								
Elementary	0.01	0.02	0.56	0.41	406.02	302.19	2.46	2.85
High School	-0.01	0.02	-0.01	0.32	-76.00	232.41	0.69	2.19
College	0.01	0.02	-0.37	0.34	-309.62	251.35	6.35	2.37
Not Reported	-0.01	0.07	-0.18	1.43	-20.40	1046.64	-9.49	9.88
Female Head								
Elementary	0.00	0.02	0.02	0.30	80.50	223.70	-2.31*	2.11
High School	0.02	0.01	0.08	0.11	139.31	81.48	3.23	0.77
College	0.03	0.01	0.25	0.20	443.64	148.15	7.10	1.40
Not Reported	-0.05	0.07	-0.36	1.39	-663.45	1022.43	-8.01	9.66

* $p < 0.01$
** $p \leq 0.001$

deviation values indicating the nutrient density consumption relationships among the various groups or levels within a factor, always compared with the overall mean nutrient density consumption for the factor. A negative deviation value at a particular factor level does not necessarily imply that the level or group was not meeting the recommended nutrient density standard for a specific nutrient. It does indicate that the diet of the group had a lower average nutrient density when compared with the estimated overall mean density for that nutrient or when compared to other levels or groups which were within the same factor and whose deviation values were more positive. Thus, the regression coefficients or deviation values designate the differential effects of the qualitative factor levels on the value of the dependent variable, nutrient density.

Control variables. Results of the analysis indicated that the control variables sex, age, height and weight of individuals and the sex by age interaction were significant factors affecting the nutrient density of diets. The nutrients which were affected differed for each of the different control variables (Appendix B). The control variables were retained in the model in order to adjust for their effects on the relationships between the dependent and independent variables of primary interest.

Income. Income was represented in the nutrient density consumption model by seven discrete classes. Tests for significant differences in nutrient densities of diets by income level were made relative to the average nutrient intake per 1000 kcal computed from the sample. Analysis of estimates of the mean nutrient density of diets in each of the seven discrete income classes indicated that income had no significant effect on nutrient density of diets (Table 4). There also was no significant relationship between income and average daily calorie consumption.

Geographic area. Geographic area was represented in the model by four regions: northeast, north central, south and west. The geographic region of the place of residence had a significant effect upon individual calcium and vitamin C intakes per 1000 kcal after adjusting for the effects of the other independent variables in the model (Table 4). There were no significant relationships between geographic region and average daily caloric intake or average nutrient intake per 1000 kcal for the other nutrients included in the model.

Average daily calcium intake per 1000 kcal was lowest for the southern region of the United States, averaging 23.71 mg less than the estimated national average for calcium intake on a calorie basis (Table 6). The western region had the highest average calcium density of diets, averaging 15.81 mg/1000 kcal more than the overall sample mean. Mean daily calcium intakes per 1000 kcal in the northeast and north central regions of the U.S. were also greater than the estimated national average for calcium intake on a nutrient density basis.

The southern region of the U.S. had the lowest vitamin C intakes per 1000 kcal when compared with other geographic regions (Table 8). Average diets in the north central and western regions also were lower in vitamin C density than the estimated national average. Vitamin C intake per 1000 kcal was highest in the northeastern region, averaging 4.74 mg more than the overall mean for vitamin C density.

Urbanization. Households were classified into one of three urbanization categories: central city, suburban and non-metropolitan. After controlling for the effects of the other variables in the model, significant relationships were found between the degree of urbanization of the place of residence and the average niacin, vitamin B_6 and vitamin C densities of individual diets (Table 4).

Performed niacin intake per 1000 kcal was highest in central city areas, averaging 0.27 mg/1000 kcal above the estimated overall mean for the sample (Table 7). Average diets in suburban areas also had niacin densities greater than the estimated national average. Mean daily intake of performed niacin on a calorie basis was lower in non-metropolitan areas.

Vitamin B_6 intake on a nutrient density basis was also highest in central city and suburban areas and lowest in non-metropolitan areas (Table 8). Average vitamin B_6 intakes in central city and suburban areas were 0.03 and 0.01 mg per 1000 kcal respectively, more than the estimated national average, whereas intake in non-metropolitan areas averaged 0.03 mg per 1000 kcal less than the overall average.

Mean intake of vitamin C on a calorie basis was highest in suburban and central city areas and lowest in non-metropolitan areas (Table 8).

Household size. Household size was represented in the nutrient density consumption model by four classes: one household member, two household members, three to four members and five or more members. The size of the household in which an individual resided was significantly related to the nutrient density of diets of individual household members with respect to fat, carbohydrate, vitamin B_6 and vitamin C intakes per 1000 kcal (Table 4).

Individual nutrient density consumption patterns of fat and carbohydrate appeared to be negatively correlated within households of different sizes. Average intake of fat on a calorie basis was highest for the group of individuals residing in households with two household members (Table 5). Conversely, carbohydrate intake per 1000 kcal was lowest for this group when compared with average intakes of the other household size group. Individuals residing in households with five or more members had the lowest fat intake per 1000 kcal and the highest carbohydrate per 1000 kcal when compared with the other groups. The group of individuals residing in single person households consumed diets below the national average in terms of carbohydrate density, but above average in terms of fat density.

Fat consumption per 1000 kcal was below the estimated national average for individuals residing in households with three to four members, whereas carbohydrate consumption on a calorie basis for this group was above the average. Thus, on a nutrient density basis, diets of individuals residing in households with one or two members had a higher fat content, but a lower carbohydrate content when compared with diets of individuals residing in larger households.

With respect to vitamin B_6 and vitamin C consumption per 1000 kcal, individuals residing in households with three to four members or five or more members, had intakes lower than the estimated national average (Table 8). Diets of individuals residing in households with one member or two members had vitamin B_6 and vitamin C densities greater than the national average. Single person households appeared to have diets with the highest vitamin B_6 and vitamin C densities whereas individuals living in households with five or more members appeared to consume the lowest of all the groups with respect to vitamin B_6 and vitamin C density of diets.

Race. The factor for race or ethnic origin was represented in the model by four levels or categories: white, black, Spanish and other. The race or ethnic origin of individuals was significantly related to average daily calcium, magnesium, vitamin A and thiamin intakes per 1000 kcal. There were no differences among the racial or ethnic groups with respect to average caloric intake or nutrient intake per 1000 kcal for other nutrients included in the analysis (Table 4).

Average calcium densities were lowest in the diets of Spanish and black groups, averaging 39.58 and 31.19 mg/1000 kcal, respectively, less than the estimated national average for calcium density (Table 6). Mean calcium consumption on a calorie basis was highest for the group of individuals for whom specific racial or ethnic origin data were not available. The group of white individuals consumed diets with an average calcium density greater than the estimated national average by approximately 5.20 mg/1000 kcal.

Magnesium intake on a calorie basis was lowest for the group of black individuals, averaging 7.68 mg/1000 kcal less than the estimated overall mean (Table 6). Diets of Spanish individuals had magnesium densities which were slightly lower than the national average. Average magnesium intake per 1000 kcal was greater than the overall sample mean for the white and "other" categories.

The average nutrient density of diets with respect to vitamin A appeared to be lowest for the group of Spanish individuals and highest for the "other" category (Table 8). White individuals had diets with average vitamin A concentration less than the estimated national averages whereas the group of black individuals were above average in terms of vitamin A consumption per 1000 kcal.

Average thiamin intake per 1000 kcal was lowest among the group of white individuals and highest among the Spanish and "other" groups (Table 7). The group of black individuals consumed diets with mean thiamin densities which appeared to be equivalent to the estimated national average.

Employment status of the household heads. Categories for the factor representing employment status of the male and female heads of the household included employed, not employed and not reported. The employment status of the male head of the household was the only socioeconomic variable in the model which had a significant impact upon average daily caloric intake. Male head employment status was also significantly related to carbohydrate and magnesium intakes per 1000 kcal. Employment status of the female head of the household had a significant effect on the nutrient density of diets only with respect to calcium consumption per 1000 kcal (Table 4).

Average daily caloric intake was highest among individuals residing in households where the male head was employed (Table 5). Daily caloric consumption for this group averaged 100.44 kcal above the estimated overall mean. For those individuals residing in households where the male head was not employed, average caloric intake was 66.09 kcal below the sample average. This implies that individuals residing in households with an unemployed male head, consume, on a daily basis, an average 166.53 kcal less than individuals residing in households with an employed male head.

The average carbohydrate density of diets appeared to be lower among individuals residing in households with an employed male head as compared with an unemployed male head (Table 5). However, the carbohydrate density of diets of both of these groups was lower than the estimated overall mean, because of the contribution of comparatively higher carbohydrate densities of diets of individuals in the "not reported" category.

Magnesium intakes on a calorie basis were lower for individuals residing in households with an employed male head as compared to the group with an unemployed male head (Table 6). Highest magnesium intake per 1000 kcal was for the group of individuals residing in households for which employment status of the male head was not reported.

Average calcium densities of individual diets were greater than the overall sample average regardless of whether the female head of the household was employed or not employed outside the home (Table 6). Average calcium intake per 1000 kcal was greater than the estimated national average by 19.37 mg/1000 kcal and 36.33 mg/1000 kcal for these two groups, respectively. For those individuals residing in households for which the employment status of the female head was not reported, average calcium density of diets was below the estimated national average.

Educational attainment of the household heads. Educational attainment of the heads of households was classified into one of four discrete classes: elementary school or less, at least some high school, at least some college and not reported. Results of the analysis indicated that education level of the male head of the household had a significant effect upon the carbohydrate density of diets of household members. Education level of the female head was significantly related to magnesium and vitamin C densities of diets of individual household members (Table 4).

Individuals residing in households for which the male head educational level was not reported, consumed, on the average, the least amount of carbohydrate per 1000 kcal when compared with the other three categories (Table 5). Carbohydrate intake for the "not reported" category was 19.00 gm/1000 kcal less than the estimted national average. Carbohydrate consumption on a nutrient density basis was approximately equivalent for the other three groups. For the elementary school, high school and college categories, carbohydrate intake was greater than the overall sample mean by 6.98, 6.24 and 5.78 gm/1000 kcal, respectively.

Average vitamin C intake on a nutrient density basis appeared to be highest for individuals residing in households in which the female head had attended college and lowest in the "not reported" category. Vitamin C intakes per 1000 kcal were below the estimated overall mean by 2.31 mg/1000 kcal for the elementary school group. The group of individuals residing in households with a female head who had at least some high school education consumed diets which averaged 3.23 mg/1000 kcal above the sample average for vitamin C density.

Nutritional Quality of Diets

Nutrient density profiles, or bar graphs, in which the length of the bars represent the INQ, or the percent of the standard of nutrients provided in the diet relative to calories, are presented in Figures 2 to 10 for each socioeconomic factor included in the model. The Index of Nutritional Quality values are based upon adjusted mean nutrient intake per 1000 kcal of individuals within each factor level (Appendix C) and standard nutrient allowances per 1000 kcal (Table 3). The adjusted means were computed as part of the multiple regression analysis and thus, the statistical test results reported previously also applied to the analysis of these data. The socioeconomic factors which had a statistically significant effect upon the mean nutrient intake per 1000 kcal were, therefore, the same factors as indicated in Table 4.

The nutrient density profiles in Figures 2 to 10 illustrate which factors were significantly related to nutrient density consumption in the sampled population. For those factors and nutrients which were not significantly related, the INQ value for the factor represents the estimated national average for consumption of the nutrient on a calorie basis. INQ values were computed and reported at each level of a factor when a statistically significant relationship existed between that factor and a specific nutrient intake per 1000 kcal. Alphabetic superscripts indicate which of these factor level means and INQ values should be considered equivalent based upon the results of Fisher's LSD

Nutrient	STD/1000 kcal	INQ	0.0 0.5 1.0 1.5 2.0
Energy	1000 kcal	1.00	XXXXXXXXXXXXXXXXXX
Protein	25 gm	1.67*	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
Fat	39 gm	1.16	XXXXXXXXXXXXXXXXXXXX
CHO	137.5 gm	0.77	XXXXXXXXXXXXX
Calcium	450 mg	0.89	XXXXXXXXXXXXXXX
Iron	8 mg	0.86	XXXXXXXXXXXXXXX
Magnesium	150 mg	0.91	XXXXXXXXXXXXXXXX
Phosphorus	450 mg	1.41	XXXXXXXXXXXXXXXXXXXXXXXX
Vitamin A	2000 IU	1.54	XXXXXXXXXXXXXXXXXXXXXXXXXX
Thiamin	0.5 mg	1.38	XXXXXXXXXXXXXXXXXXXXXXX
Riboflavin	0.6 mg	1.58	XXXXXXXXXXXXXXXXXXXXXXXXXX
Niacin	7.0 mg	1.48	XXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin B_6	1.0 mg	0.79	XXXXXXXXXXXXXX
Vitamin B_{12}	1.5 µg	1.97	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin C	30 mg	1.59	XXXXXXXXXXXXXXXXXXXXXXXXXXX

*Data were averaged over all income levels due to lack of statistical significance among income categories.

Figure 2. Nutrient density profile: average nutrient consumption per 1000 kcal by income levels.

Nutrient	STD/1000 kcal	INQ	0.0 0.5 1.0 1.5 2.0
Energy	1000 kcal	1.0	XXXXXXXXXXXXXXXXXX
Protein	25 gm	1.67*	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
Fat	39 gm	1.16	XXXXXXXXXXXXXXXXXXXX
Carbohydrate	137.5 gm	0.77	XXXXXXXXXXXX
Calcium	450 mg	0.89[a] 0.90[a] 0.84[b] 0.92[a]	111111111111111 222222222222222 33333333333333 4444444444444444
Iron	8 mg	0.86	XXXXXXXXXXXXXXX
Magnesium	150 mg	0.91	XXXXXXXXXXXXXXXX
Phosphorus	450 mg	1.41	XXXXXXXXXXXXXXXXXXXXXXXX
Vitamin A	2000 IU	1.54	XXXXXXXXXXXXXXXXXXXXXXXXXX
Thiamin	0.5 mg	1.38	XXXXXXXXXXXXXXXXXXXXXXX
Riboflavin	0.6 mg	1.58	XXXXXXXXXXXXXXXXXXXXXXXXXX
Niacin	7.0 mg	1.48	XXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin B_6	1.0 mg	0.79	XXXXXXXXXXXXXX
Vitamin B_{12}	1.5 μg	1.97	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin C	30 mg	1.75[a] 1.52[b] 1.50[b] 1.59[b]	11111111111111111111111111111 2222222222222222222222222 3333333333333333333333333 44444444444444444444444444

*Nutrients with a single average INQ value were not significantly affected by region. Nutrients with different alphabetic superscripts had significantly different INQ values at $p \leq 0.01$ for 1 = northeast, 2 = north central, 3 = south, 4 = west.

Figure 3. Nutrient density profile: average nutrient consumption per 1000 kcal by region categories.

Nutrient	STD/1000 kcal	INQ	0.0 0.5 1.0 1.5 2.0
Energy	1000 kcal	1.00	XXXXXXXXXXXXXXXXXX
Protein	25 gm	1.67*	XXXXXXXXXXXXXXXXXXXXXXXXX
Fat	39 gm	1.16	XXXXXXXXXXXXXXXXX
Carbohydrate	137.5 gm	0.77	XXXXXXXXXXXXXX
Calcium	450 mg	0.89	XXXXXXXXXXXXXXX
Iron	8 mg	0.86	XXXXXXXXXXXXXXX
Magnesium	150 mg	0.91	XXXXXXXXXXXXXXXX
Phosphorus	450 mg	1.41	XXXXXXXXXXXXXXXXXXXXXXX
Vitamin A	2000 IU	1.54	XXXXXXXXXXXXXXXXXXXXXXXXXXX
Thiamin	0.5 mg	1.38	XXXXXXXXXXXXXXXXXXXXXXX
Riboflavin	0.6 mg	1.58	XXXXXXXXXXXXXXXXXXXXXXXXXX
Niacin	7.0 mg	1.52^{a} 1.49^{a} 1.43^{b}	1111111111111111111111111 2222222222222222222222222 333333333333333333333333
Vitamin B_6	1.0 mg	0.81^{a} 0.79^{a} 0.75^{b}	11111111111111 2222222222222 333333333333
Vitamin B_{12}	1.5 μg	1.97	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin C	30 mg	1.63^{a} 1.66^{a} 1.47^{b}	1111111111111111111111111111111111 2222222222222222222222222222222222 3333333333333333333333333333

*Nutrients with a single average INQ value were not significantly affected by degree of urbanization. Nutrients with different alphabetic superscripts had significantly different INQ values at $p \leq 0.01$ for 1 = central city, 2 = suburban, 3 = non-metropolitan.

Figure 4. Nutrient density profile: average nutrient consumption per 1000 kcal by urbanization levels.

Nutrient	STD/1000 kcal	INQ	0.0 0.5 1.0 1.5 2.0
Energy	1000 kcal	1.0	XXXXXXXXXXXXXXXXXX
Protein	25 gm	1.67*	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
Fat	39 gm	1.17^{a}	11111111111111111111
		1.18^{a}	22222222222222222222
		1.15^{a}	3333333333333333333
		1.13^{b}	4444444444444444444
Carbohydrate	137.5 gm	0.75^{a}	1111111111111
		0.75^{a}	2222222222222
		0.78^{b}	33333333333333
		0.79^{b}	44444444444444
Calcium	450 mg	0.89	XXXXXXXXXXXXXXX
Iron	8 mg	0.86	XXXXXXXXXXXXXXX
Magnesium	150 mg	0.91	XXXXXXXXXXXXXXXX
Phosphorus	450 mg	1.41	XXXXXXXXXXXXXXXXXXXXXXXX
Vitamin A	2000 IU	1.54	XXXXXXXXXXXXXXXXXXXXXXXXXX
Thiamin	0.5 mg	1.38	XXXXXXXXXXXXXXXXXXXXXXX
Riboflavin	0.6 mg	1.58	XXXXXXXXXXXXXXXXXXXXXXXXXX
Niacin	7.0 mg	1.48	XXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin B_6	1.0 mg	0.83^{a}	11111111111111
		0.82^{a}	22222222222222
		0.76^{b}	3333333333333
		0.73^{b}	4444444444444
Vitamin B_{12}	1.5 μg	1.97	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin C	30 mg	1.89^{a}	1111111111111111111111111111111
		1.62^{b}	222222222222222222222222222
		1.47^{b}	3333333333333333333333333
		1.37^{c}	44444444444444444444444

*Nutrients with a single average INQ value were not significantly affected by household size. Nutrients with different alphabetic superscripts had significantly different INQ values at $p \leq 0.01$ for 1 = member, 2 = 2 members, 3 = 3 to 4 members, 4 = 5 or more members.

Figure 5. Nutrient density profile: average nutrient consumption per 1000 kcal by household size categories.

Nutrient	STD/1000 kcal	INQ	0.0 0.5 1.0 1.5 2.0
Energy	1000 kcal	1.00	XXXXXXXXXXXXXXXXXX
Protein	25 gm	1.67*	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
Fat	39 gm	1.16	XXXXXXXXXXXXXXXXXXXX
Carbohydrate	137.5 gm	0.77	XXXXXXXXXXXXX
Calcium	450 mg	0.90[a]	111111111111111
		0.82[b]	22222222222222
		0.80[b]	33333333333333
		1.03[c]	444444444444444444
Iron	8 mg	0.86	XXXXXXXXXXXXXXX
Magnesium	150 mg	0.93[a]	1111111111111111
		0.86[b]	222222222222222
		0.93[a]	3333333333333333
		0.94[a]	4444444444444444
Phosphorus	450 mg	1.41	XXXXXXXXXXXXXXXXXXXXXXXX
Vitamin A	2000 IU	1.39[a]	11111111111111111111111
		1.79[b]	222222222222222222222222222222
		0.95[c]	33333333333333333
		2.04[b]	4444444444444444444444444444444444
Thiamin	0.5 mg	1.28[a]	111111111111111111111
		1.38[b]	22222222222222222222222
		1.48[c]	3333333333333333333333333
		1.40[b]	44444444444444444444444
Riboflavin	0.6 mg	1.58	XXXXXXXXXXXXXXXXXXXXXXXXXX
Niacin	7.0 mg	1.48	XXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin B_6	1.0 mg	0.79	XXXXXXXXXXXXXX
Vitamin B_{12}	1.5 µg	1.97	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin C	30 mg	1.59	XXXXXXXXXXXXXXXXXXXXXXXXXXX

*Nutrients with a single average INQ value were not significantly affected by race. Nutrients with different alphabetic superscripts had significantly different INQ values at $p \leq 0.01$ for 1=white, 2=black, 3=Spanish, 4=other.

Figure 6. Nutrient density profile: average nutrient consumption per 1000 kcal by race categories.

Nutrient	STD/1000 kcal	INQ	0.0 0.5 1.0 1.5 2.0
Energy	1000 kcal	1.0	XXXXXXXXXXXXXXXXXX
Protein	25 gm	1.67*	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
Fat	39 gm	1.16	XXXXXXXXXXXXXXXXXXXX
Carbohydrate	137.5 gm	0.71[a]	111111111111
		0.72[a]	222222222222
		0.88[b]	333333333333333
Calcium	450 mg	0.89	XXXXXXXXXXXXXXX
Iron	8 mg	0.86	XXXXXXXXXXXXXXX
Magnesium	150 mg	0.84[a]	11111111111111
		0.89[b]	222222222222222
		0.99[c]	33333333333333333
Phosphorus	450 mg	1.41	XXXXXXXXXXXXXXXXXXXXXXXX
Vitamin A	2000 IU	1.54	XXXXXXXXXXXXXXXXXXXXXXXXXX
Thiamin	0.5 mg	1.38	XXXXXXXXXXXXXXXXXXXXXXX
Riboflavin	0.6 mg	1.58	XXXXXXXXXXXXXXXXXXXXXXXXXX
Niacin	7.0 mg	1.48	XXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin B_6	1.0 mg	0.79	XXXXXXXXXXXXXX
Vitamin B_{12}	1.5 μg	1.97	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin C	30 mg	1.59	XXXXXXXXXXXXXXXXXXXXXXXXXXX

*Nutrients with a single average INQ value were not significantly affected by male head employment status. Nutrients with different alphabetic superscripts had significantly different INQ values at $p \leq 0.01$ for 1 = employed, 2 = not employed, 3 = not reported.

Figure 7. Nutrient density profile: average nutrient consumption per 1000 kcal by male household head employment status.

Nutrient	STD/1000 kcal	INQ	0.0 0.5 1.0 1.5 2.0
Energy	1000 kcal	1.0	XXXXXXXXXXXXXXXXXX
Protein	25 gm	1.67*	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
Fat	39 gm	1.16	XXXXXXXXXXXXXXXXXXXX
Carbohydrate	137.5 gm	0.74	XXXXXXXXXXXXX
Calcium	450 mg	0.92[a]	1111111111111111
		0.97[a]	22222222222222222
		0.77[b]	3333333333333
Iron	8 mg	0.86	XXXXXXXXXXXXXXX
Magnesium	150 mg	0.91	XXXXXXXXXXXXXXXX
Phosphorus	450 mg	1.41	XXXXXXXXXXXXXXXXXXXXXXXX
Vitamin A	2000 IU	1.54	XXXXXXXXXXXXXXXXXXXXXXXXXX
Thiamin	0.5 mg	1.38	XXXXXXXXXXXXXXXXXXXXXXX
Riboflavin	0.6 mg	1.58	XXXXXXXXXXXXXXXXXXXXXXXXXX
Niacin	7.0 mg	1.48	XXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin B_6	1.0 mg	0.79	XXXXXXXXXXXXXX
Vitamin B_{12}	1.5 μg	1.97	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin C	30 mg	1.59	XXXXXXXXXXXXXXXXXXXXXXXXXXX

*Nutrients with a single average INQ value were not significantly affected by female head employment status. Nutrients with different alphabetic superscripts had significantly different INQ values at $p \leq 0.01$ for 1 = employed, 2 = not employed, 3 = not reported.

Figure 8. Nutrient density profile: average nutrient consumption per 1000 kcal by female household head employment status.

Nutrient	STD/1000 kcal	INQ	0.0 0.5 1.0 1.5 2.0
Energy	1000 kcal	1.00	XXXXXXXXXXXXXXXXXX
Protein	25 gm	1.67*	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
Fat	39 gm	1.16	XXXXXXXXXXXXXXXXXXXX
Carbohydrate	1.37 gm	0.82^{a}	11111111111111
		0.82^{a}	22222222222222
		0.81^{a}	33333333333333
		0.63^{b}	44444444444
Calcium	450 mg	0.89	XXXXXXXXXXXXXXX
Iron	8 mg	0.86	XXXXXXXXXXXXXXX
Magnesium	150 mg	0.91	XXXXXXXXXXXXXXXX
Phosphorus	450 mg	1.41	XXXXXXXXXXXXXXXXXXXXXXXX
Vitamin A	2000 IU	1.54	XXXXXXXXXXXXXXXXXXXXXXXXXX
Thiamin	0.5 mg	1.38	XXXXXXXXXXXXXXXXXXXXXXX
Riboflavin	0.6 mg	1.58	XXXXXXXXXXXXXXXXXXXXXXXXXX
Niacin	7.0 mg	1.48	XXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin B_6	1.0 mg	0.79	XXXXXXXXXXXXXX
Vitamin B_{12}	1.5 μg	1.97	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin C	30 mg	1.59	XXXXXXXXXXXXXXXXXXXXXXXXXXX

*Nutrients with a single average INQ value were not significantly affected by male head education level. Nutrients with different alphabetic superscripts had significantly different INQ values at $p \leq 0.01$ for 1 = elementary, 2 = high school, 3 = college, 4 = not reported.

Figure 9. Nutrient density profile: average nutrient consumption per 1000 kcal by male household head education level.

Nutrient	STD/1000 kcal	INQ	0.0 0.5 1.0 1.5 2.0
Energy	1000 kcal	1.00	XXXXXXXXXXXXXXXXXX
Protein	25 gm	1.67*	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
Fat	39 gm	1.16	XXXXXXXXXXXXXXXXXXXX
Carbohydrate	137.5 gm	0.77	XXXXXXXXXXXXX
Calcium	450 mg	0.89	XXXXXXXXXXXXXXX
Iron	8.0 mg	0.86	XXXXXXXXXXXXXXX
Magnesium	150 mg	0.91	XXXXXXXXXXXXXXXX
Phosphorus	450 mg	1.41	XXXXXXXXXXXXXXXXXXXXXXXX
Vitamin A	2000 IU	1.54	XXXXXXXXXXXXXXXXXXXXXXXXXX
Thiamin	0.5 mg	1.38	XXXXXXXXXXXXXXXXXXXXXXX
Riboflavin	0.6 mg	1.58	XXXXXXXXXXXXXXXXXXXXXXXXXX
Niacin	7.0 mg	1.48	XXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin B_6	1.0 mg	0.79	XXXXXXXXXXXXXX
Vitamin B_{12}	1.5 μg	1.97	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Vitamin C	30 mg	1.51^{a}	1111111111111111111111111
		1.70^{b}	2222222222222222222222222222
		1.82^{b}	333333333333333333333333333333
		1.32^{c}	4444444444444444444444

*Nutrients with a single average INQ value were not significantly affected by female head education level. Nutrients with different alphabetic superscripts had significantly different INQ values at $p \leq 0.01$ for 1 = elementary, 2 = high school, 3 = college, 4 = not reported.

Figure 10. Nutrient density profile: average nutrient consumption per 1000 kcal by female household head education level.

test.

For nutrients that show a wide range of values or a number of exceptionally high or low values, median values often provide a more meaningful reflection of nutrient intake than do mean values. Median values for nutrient intake per 1000 kcal and the percent of individuals with intakes below nutrient density standards, i.e., with INQ values less than one, were computed for each population group. These data are reported in Appendix C, along with average nutrient density consumption values. In this study, median intakes per 1000 kcal were generally lower than corresponding mean intakes with respect to calcium, iron, magnesium, phosphorus, vitamin A, riboflavin, vitamin B_{12} and vitamin C intakes per 1000 kcal.

Income. Income was the only factor in the nutrient density consumption model which was not significantly related to nutrient consumption per 1000 kcal for any nutrient. Thus, the data in the nutrient density profile for income categories (Figure 2) represent the estimated nutritional quality of diets in the United States averaged over all income levels.

The data indicate that, on the average, 1000 kilocalories of consumed diet met and exceeded nutrient standards for protein, fat, phosphorus, vitamin A, thiamin, riboflavin, niacin, vitamin B_{12} and vitamin C. Among the income categories, the percent of individuals below recommended standards ranged from 0.9 to 1.5 percent for protein and 4.8 to 6.4 percent for phosphorus. For the other nutrients the percentages of individuals with nutrient densities below standard were somewhat higher, despite the fact the mean consumption appeared to be adequate. The percent individuals below standards for thiamin, riboflavin and niacin densities, ranged from eight to 20 percent depending upon the nutrient and the reported income level (Appendix C). Intake data for niacin were based upon calculations of the amounts of preformed niacin in the foods consumed and did not account for the amount of the amino acid tryptophan which could be converted in the body to niacin. Thus, it is somewhat misleading to compare the niacin values of diets with a dietary standard. In general, the niacin available from the trypotophan present in protein is sufficient to elevate total niacin value of most diets to the standard level. For these reasons, no special discussion of niacin intakes is included in the following sections.

Sixteen to 25 percent of individuals had diets below standard in terms of vitamin B_{12} density (Appendix C). Approximately one-third of individuals at each income level had vitamin C intakes less than recommended standards on a calorie basis, and as much as 50 percent of the sampled population in some income categories had vitamin A intakes less than standard.

Nutritional problems regarding fat intake are usually related to excessive rather than insufficient intakes, thus, the standard of 39 gm per 1000 calorie is based upon the U.S. Dietary Goal to reduce fat consumption to approximately 30 percent of energy intake. The percentage of individuals with dietary fat densities below standard ranged from approximately 17 to 25 percent for the various income categories, implying that 75 to 80 percent of the population consumed diets with excessive concentration of fat.

Nutrients for which mean consumption per 1000 kcal was below recommended nutrient density standards included calcium, iron, magnesium, vitamin B_6 and carbohydrate (Figure 2). Average consumption of these nutrients on a calorie basis ranged from 77 to 91 percent of standard. Approximately two-thirds of the sampled population consumed less than standard amounts of calcium on a nutrient density basis (Appendix C). Seventy-five to 85 percent of individuals were below standard in terms of iron density of diets. The single-value standard of 8 mg iron per 1000 kcal is somewhat high for males, thus the relatively high proportion of dietary "iron-deficient" individuals does not accurately reflect dietary iron status of the population.

The estimated percentage of individuals with magnesium and vitamin B_6 densities below standard ranged from 67 to 86 percent of the population (Appendix C). However, the food composition values for magensium and vitamin B_6 are still somewhat tentative, thus the reliability of these data is less certain than for other nutrients. Approximately 90-95 percent of the population had dietary carbohydrate densities less than the recommended standard which is based upon the U.S. Dietary Goal of 58 percent of calories from carbohydrate sources.

Geographic region. Geographic region had a significant effect upon average daily calcium and vitamin C intake per 1000 kcal (Table 4). Average calcium intakes on a nutrient density were below standard in all regions of the country (Figure 3). The south had the lowest INQ value, 0.84, for calcium. Results of the LSD test indicated that average calcium intake per 1000 kcal were equivalent in the northeastern, north central and western regions in the U.S. Thus, the South differed from the rest of the U.S. in terms of average calcium quality of diets.

Median values for calcium intake per 1000 kcal were consistently lower than mean values for all regional categories, with the lowest values in the south and highest values in the west (Appendix C). Seventy-six percent of the sampled southern population had calcium densities below standard, whereas 56 percent of the western population was below standard. Approximately 65% of individuals in the northeast and north central region had calcium intakes which were below standard on a calorie basis.

Vitamin C intakes per 1000 kcal in all four geographic regions averaged at least 50 percent above recommended standards (Figure 3). Highest average consumption of vitamin C on a nutrient density basis was in the northeastern region of the U.S., and this region also had the lowest percentage (30.1%) of individuals below standard (Appendix C). Results of the LSD test indicated that average vitamin C densities of diets were equivalent in the northcentral, south and western regions of the U.S. (Figure 3).

Urbanization. The degree of urbanization of the place of residence significantly affected the nutritional quality of diets with respect to preformed niacin, vitamin B_6 and vitamin C intakes per 1000 kcal (Table 4). Niacin intake in all urbanization categories averaged at least 40 percent above standards (Figure 4).

INQ values for vitamin B_6 indicated that inadequate amounts of this nutrient were consumed on a nutrient density basis at all urbanization levels (Figure 4). Lowest average consumption of vitamin B_6 occurred in non-metropolitan regions where 85.8% of the population had diets below standard on a calorie basis (Appendix C). Average diets of individuals residing in central city and suburban areas averaged equivalent vitamin B_6 densities, according to the results of the LSD test. Median consumption was highest in suburban areas whereas the percent individuals below standard was lowest (Appendix C).

Mean vitamin C intakes per 1000 kcal were equivalent in central city and suburban areas, but significantly lower in non-metropolitan areas (Figure 4). Average consumption was greater than the standard at all urbanization levels, but median intakes were somewhat lower in all categories. Approximately 42 percent of individuals in non-metropolitan areas had vitamin C intakes below nutrient density standards (Appendix C). In central city and suburban areas, the percent below standard were 32.9 and 34.4 percent, respectively.

Household size. The size of the household in which individuals resided affected the fat, carbohydrate, vitamin B_6 and vitamin C quality of diets (Table 4).

Average fat consumption on a calorie basis was higher than recommended standards at all levels of household size (Figure 5). Individuals residing in households ranging from one to four members had significantly higher fat intakes per 1000 kcal than individuals residing in households with five or more members. Seventy-five percent of individuals in single-person households had dietary fat densities greater than the recommended standard, whereas 82 to 84 percent of individuals in 2 to 4 member households consumed diets with excess fat for the amount of calories provided (Appendix C). Mean and median fat intake values per 1000 kcal were lowest for individuals residing in households with five or more members.

INQ values for carbohydrate ranged from 0.75 for one and two member households to 0.79 for five or more member households (Figure 5). A large percentage (88 to 95%) of the population was below standard for carbohydrate consumption per 1000 kcal regardless of the size of the household in which they resided (Appendix C).

Average vitamin B_6 intake on a calorie basis was also below standard regardless of household size. Lowest mean and median intakes were among individuals residing in households with three to four or with five or more members. These group also had the highest percentage (88.9%) of individuals with vitamin B_6 densities below the standard 1.0 mg per 1000 kcal. Results of the LSD analysis indicated that individuals residing in households with one or two members consumed alike in terms of vitamin B_6 density of their diets. Individuals in households with three to four and five or more members consumed diets with equivalent concentrations of vitamin B_6, but these individuals consumed different (lower) amounts than individuals in households with one or two members (Figure 5).

Average vitamin C intake on a calorie basis was above standard in all household size categories, with single-person households having the highest average INQ value, 1.89 (Figure 5). This group also had proportionately fewer individuals with INQ values less than one, i.e., below standard. Mean and median intake of vitamin C per 1000 kcal was lowest for individuals residing in larger households with five or more members. Approximately 4.5 percent of individuals in this group had INQ values less than one (Appendix C). Individuals residing in households of size two and size three to four consumed diets with equivalent vitamin C densities, averaging INQ values between the other two groups (Figure 5).

Race. Individuals in different racial and ethnic categories differed in the nutritional quality of their diets with regards to calcium, magnesium, vitamin A and thiamin content per 1000 kcal (Table 4).

Average calcium and magnesium densities were below standard for all groups for which racial or ethnic information was available (Figure 6). The INQ for calcium was highest for the group of white individuals and lowest for the Spanish and black groups. Blacks had the lowest median value of calcium intake per 1000 kcal and the largest percent of individuals below standard (Appendix C). Average INQ values for magnesium were highest for the white and Spanish groups and lowest for blacks (Figure 6). The black and Spanish groups had 85.9 and 89.8 percent of individuals below standard for magnesium intake per 1000 kcal, whereas the group of white individuals averaged 68.3 below standard (Appendix C).

The relationship between race and vitamin A consumption was the only association in the study where the differential effects of a factor resulted in some of the factor subgroups consuming above standard nutrient density amounts whereas another group within the same factor consumed below recommended amounts on a nutrient density basis. Average INQ values for vitamin A were greater than one for whites (1.39) and blacks, but less than one for the Spanish group (0.95) (Figure 6). Average intake of vitamin A on a calorie basis was almost twice as high for black as for Spanish individuals. However, the relatively large standard error of mean consumption of the Spanish group (Appendix C) indicates a great deal of variability in consumption of vitamin A per 1000 kcal and thus decreases the reliability of the mean as a true reflection of the status of vitamin A density of diets in this group. Nevertheless, the comparatively low median value and high percentage of Spanish individuals below standard indicated that vitamin A may be a nutrient of concern for those of Spanish origin.

Average thiamin intakes per 1000 kcal were greater than the standard for all racial and ethnic categories with blacks consuming the greatest amounts and whites the least amount on a calorie basis (Figure 6). Median values were slightly higher for all subgroups, but reflected the same consumption relationships among the groups as did the means (Appendix C). The largest percent of individuals below the standard was among whites (15.39%) and lowest among blacks (10.9%), with the Spanish group inbetween (11.7%).

Male head employment status. The employment status of the male head of the household had a statistically significant impact on the carbohydrate and magnesium quality of diets of household members (Table 4). However, the major difference in carbohydrate density was between the group for which male employment status was unknown (not reported) and the other two groups (employed, not employed).

According to the results of the LSD test, carbohydrate intake per 1000 kcal was the same for individual household members regardless of whether or not the male head was employed (Figure 7). Median carbohydrate intake on a calorie basis and the percent of individuals below standard were also similar for these two groups (Appendix C). Carbohydrate consumption per 1000 kcal was below standard for both of these groups with INQ values of 0.71 and 0.72 for the employed and unemployed groups respectively.

Average magnesium intakes per 1000 kcal were below standard for individual household members regardless of whether or not the male head was employed (Figure 7). Results of the LSD tests indicated that all three groups (employed, not employed and not reported) within this factor, consumed statistically different amounts of magnesium on a calorie basis. INQ values for magnesium were 0.84 and 0.89 for the employed and not employed groups, respectively. Approximately 74 percent of individuals residing in households with an employed male head had diets below standard, whereas 61.7 percent of individuals with an unemployed male head had diets below standard (Appendix C).

Female head employment status. The employment status of the female head of the household had a significant impact upon the calcium quality of diets of household members (Table 4), but the major differences occurred between the "not reported" group and the other two groups. Average calcium intakes per 1000 kcal were below standard at all three levels of this factor (Figure 8). The INQ value for the "not employed" group was 0.97 as compared with 0.92 for the "employed" group, but the difference was not statistically significant. The percent of individuals below standard was approximately the same in both categories: 68.0 percent for the "employed" group and 67.2 percent for the "unemployed" group (Appendix C).

Male head educational level. The educational attainment of the male head of the household had an effect upon the nutritional quality of diets of individual household members only with respect to carbohydrate intake per 1000 kcal (Table 4). INQ values for carbohydrate of 0.82, 0.82 and 0.81 were statistically equivalent for the elementary school, high school and college categories, respectively (Figure 9). All groups were below the carbohydrate standard of 137.5 gm per 1000 kcal, with the "not reported" group having the lowest INQ value (0.63). The percentage of individuals below the carbohydrate standard was approximately 93 percent, regardless of the level of educational attainment of the male household head (Appendix C).

Female head educational level. The vitamin C quality of diets of individual household members was the only nutrient affected by the education level of the female head of the household (Table 4). Average vitamin C intake on a calorie basis was highest among individuals residing in households with a high school or college educated female head. INQ values of 1.82 and 1.70 for the "college" and "high school" categories were not statistically different (Figure 10). Average vitamin C densities were lower for individuals in the "not reported" category. The percent individuals with vitamin C densities below standard was lowest (28.5%) among the group with college-educated female heads and highest (40.7) among the elementary school group (Appendix C).

Interaction effects. The interaction effect of geographic location by degree of urbanization was statistically significant for protein, fat and carbohydrate intake per 1000 kcal. In the northeastern, western and southern regions protein intake on a calorie basis was higher in central city areas than in suburban areas (Figure 11). In the north central region the opposite trend occurred: protein density of diets was lower in central city areas than in suburban areas. The northeastern central city areas had the highest average protein density of diets, but in suburban areas protein density was highest in the west. Protein consumption per 1000 kcal in the northeast and west was lower in non-metropolitan than in suburban areas, whereas intake in the southern and north central regions was approximately the same in non-metropolitan and suburban areas.

Fat intake per 1000 kcal was higher in suburban than in central city areas across all regions (Figure 12). In the northeast and south, fat intake per 1000 kcal was lower in non-metropolitan areas than in either suburban or central city areas. However, in the north central region, the data for average fat consumption on a calorie basis showed an increasing trend from suburban to non-metropolitan areas. Fat density of diets in the west was approximately the same in suburban and non-metropolitan areas and was highest at all urbanization levels. Central city and suburban areas of the northeast averaged second highest in fat density of diets, but northeastern non-metropolitan areas had the lowest fat density of all regions. The north central region had the second highest fat intake in

Figure 11. Mean protein intake in grams per 1000 kcal for individuals by geographic region and urbanization level.

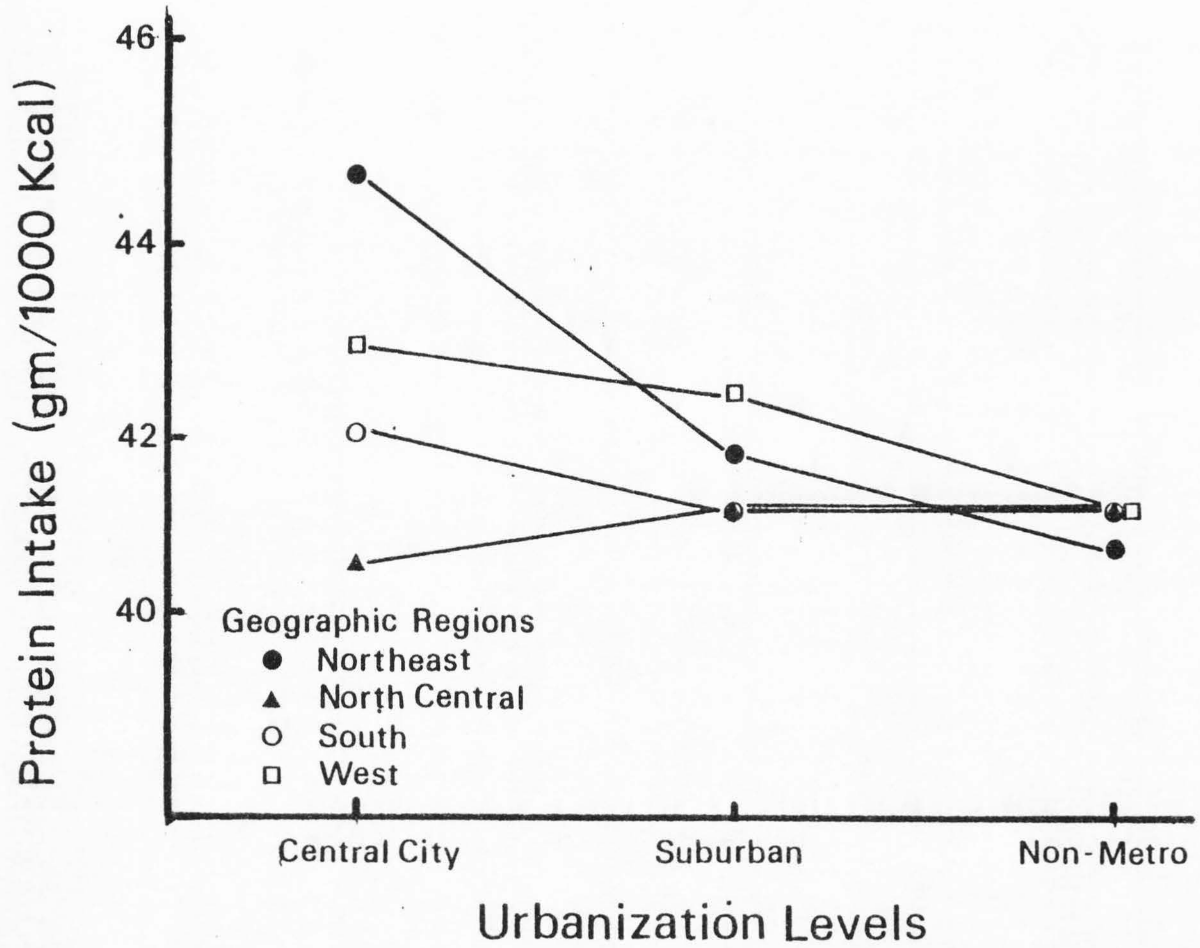
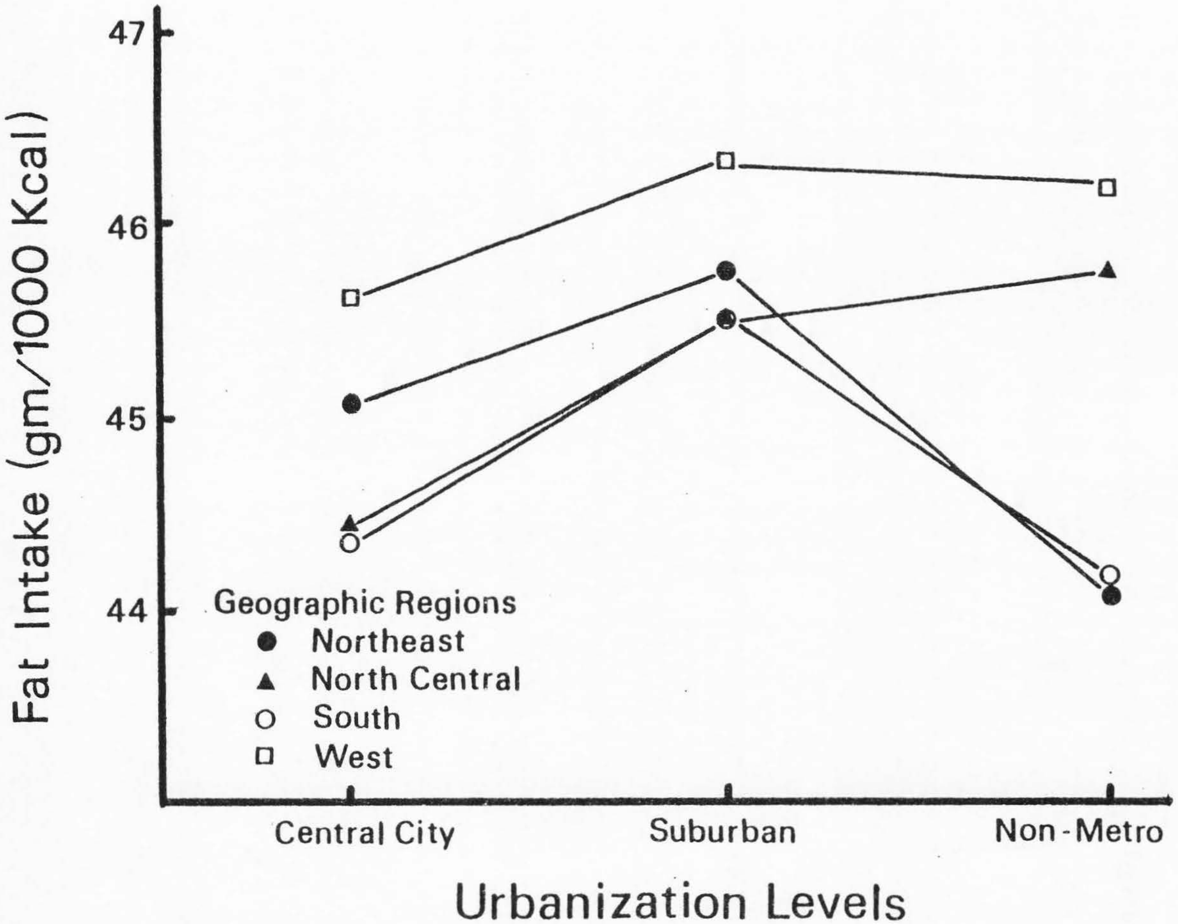

Protein Intake (gm/1000 Kcal)
46
44
42
40
Geographic Regions
Northeast
North Central
South
West
Central City
Suburban
Non-Metro
Urbanization Levels

Figure 12. Mean fat intake in grams per 1000 kcal for individuals by geographic region and urbanization level.


Fat Intake (gm/1000 Kcal)
47
46
45
44
Geographic Regions
Northeast
North Central
South
West
Central City
Suburban
Non-Metro
Urbanization Levels

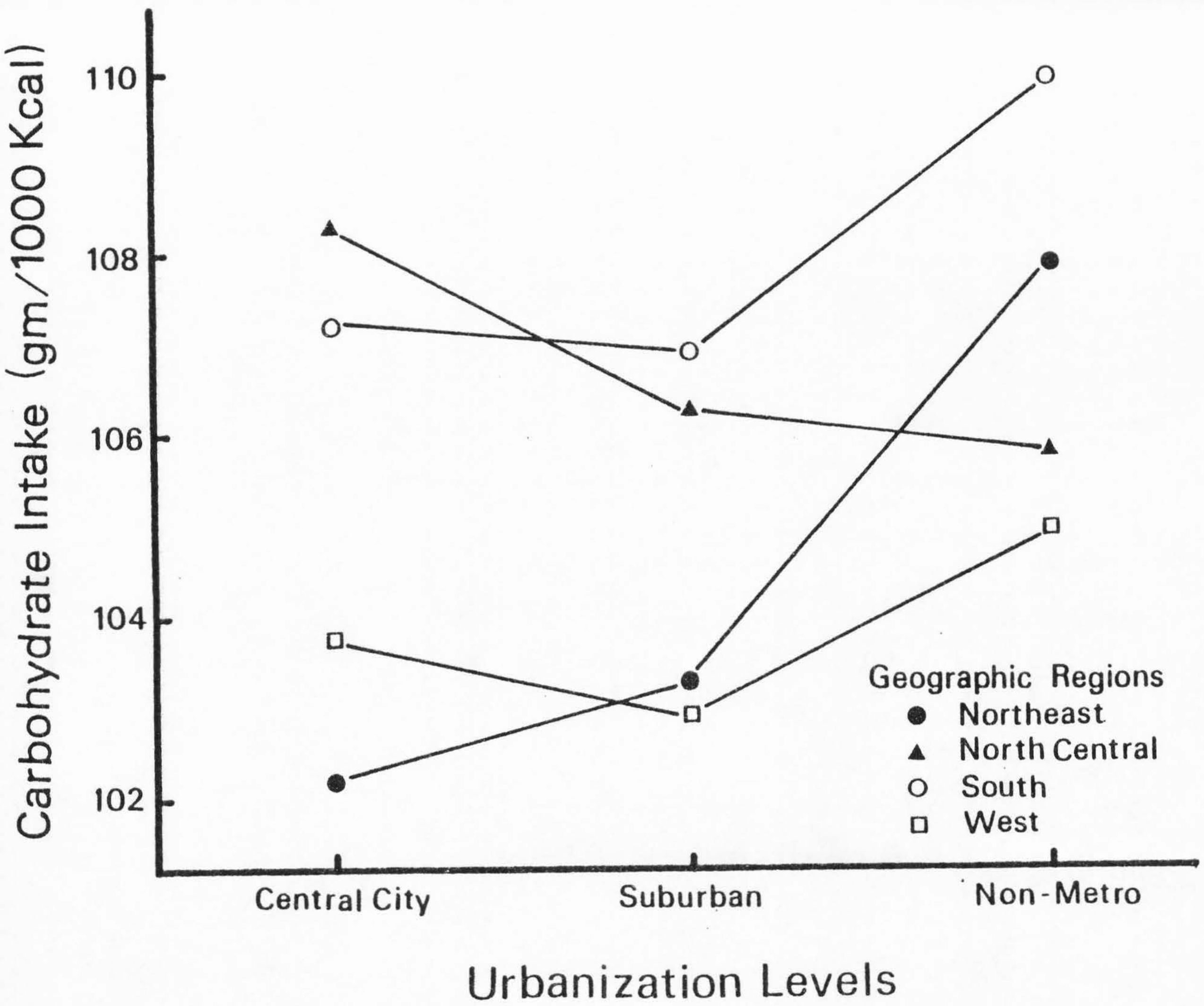
non-metropolitan areas.

Carbohydrate consumption on a nutrient density basis showed similar patterns across all urbanization levels in the south and west (Figure 13). Carbohydrate intake per 1000 kcal decreased slightly from central city to suburban areas and increased markedly in non-metropolitan areas to levels above that consumed in central city areas. Carbohydrate density of diets was consistently higher in the south than in the west at all urbanization levels. In the northeast, carbohydrate density was slightly higher in suburban than in central city areas and increased in non-metropolitan areas. Carbohydrate intake per 1000 kcal showed a decreasing trend from central city to suburban to non-metropolitan areas in the north central region.

The income by household size interaction was included in the model to provide a measure of the effect of household per capita income on the nutrient density of diets. This interaction effect was statistically significant for niacin and vitamin C intake per 1000 kcal, but not for any of the other nutrients included in the model. This implied that, except for the effects on niacin and vitamin C, there were no differential effects of per capita income on the nutritional quality of diets.

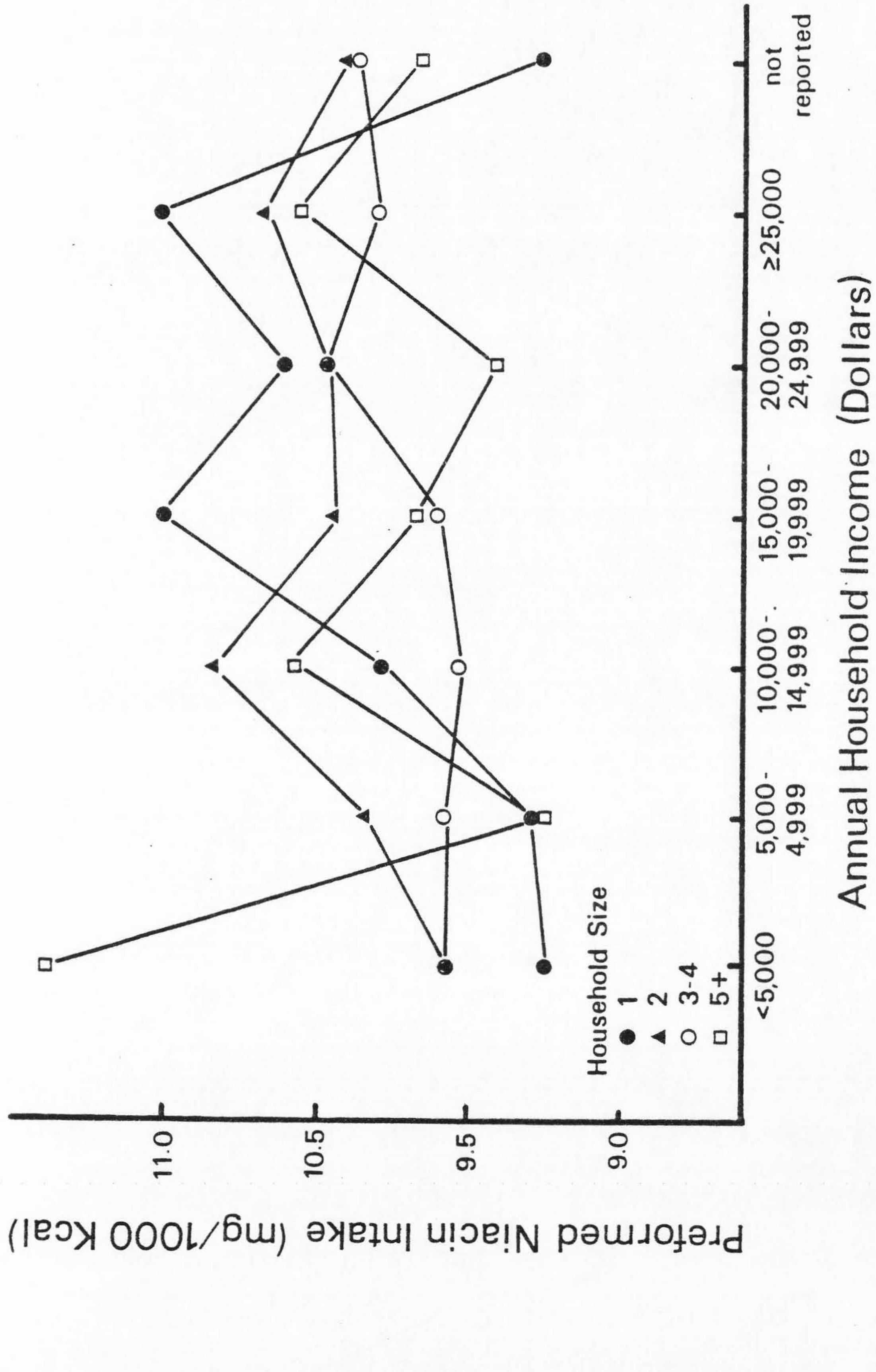
The data for the income by household size interaction effect on niacin density of diets are presented in Figure 14, but no general trends were identified. As indicated previously, the data account only for preformed niacin and do not accurately reflect dietary niacin status. Therefore, no interpretations were made regarding the interaction effects on niacin density of diets.

Figure 13. Mean carbohydrate intake in grams per 1000 kcal for individuals by geographic location and urbanization level.



Carbohydrate Intake (gm/1000 Kcal)
110
108
106
104
102
Central City
Suburban
Non-Metro
Urbanization Levels
Geographic Regions
Northeast
North Central
South
West

Figure 14. Mean niacin intake in milligrams per 1000 kcal for individuals by income level and household size.


Preformed Niacin Intake (mg/1000 Kcal)
11.0
10.5
9.5
9.0
Household Size
1
2
3-4
5+
<5,000
5,000-4,999
10,000-14,999
15,000-19,999
20,000-24,999
≥25,000
not reported
Annual Household Income (Dollars)

The effect of income per capita, as measured by the income by household size interaction, on vitamin C intake per 1000 kcal is illustrated in Figure 15. Average vitamin C density of diets of single-person households varied considerably at different income levels and exhibited some relatively high values compared to average intakes of individuals in other household size groups. These differences can be partially attributed to the smaller member of individuals in the single-person household group. The standard error of the means were more than 50 percent greater for single-person households when compared to standard errors of other household sizes. This indicated that the means in the single-person household by income cells were less reliable estimates of the average vitamin C consumption of these groups.

At the lower and upper income levels ($9,999 or less and $25,000 or more), individuals residing in households with two members had higher vitamin C intakes per 1000 kcal than individuals in three to four member households. Individuals, in these income categories who resided in households with five or more members had the lowest vitamin C density of diets. In the middle income brackets the pattern changed several times. At the $15,000 to 19,999 income level, average vitamin C intakes per 1000 kcal were approximately equivalent regardless of the size of the household in which the individual resided.

Nutrient Contribution of Food Groups

Characteristics of individuals who consumed the lowest and highest average nutritional quality of diets are summarized in Tables 9 and 10. These data reflect the results of the multiple regression

Figure 15. Mean vitamin C intake in milligrams per 1000 kcal for individuals by income level and household size.

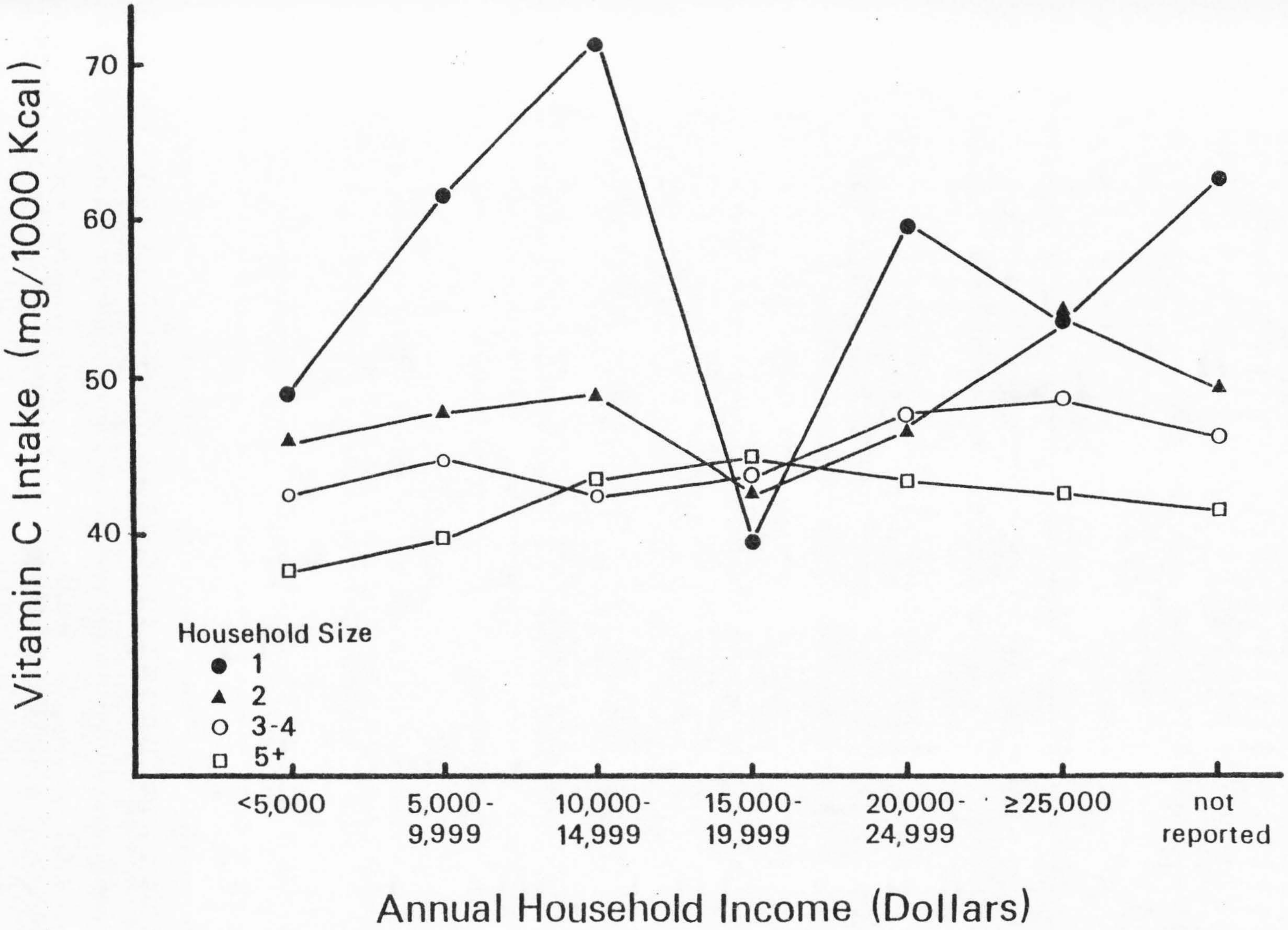

Vitamin C Intake (mg/1000 Kcal)
70
60
50
40
Household Size
1
2
3-4
5+
<5,000
5,000-9,999
10,000-14,999
15,000-19,999
20,000-24,999
≥25,000
not reported
Annual Household Income (Dollars)

Table 9. A summary of characteristics of individuals with lowest average nutritional quality of diets, United States, Spring, 1977.

Nutrient	Region	Urbanization	Income	Household Size	Race	Employment Status Male	Employment Status Female	Education Level Male	Education Level Female
Protein	-	-	-	-	-	-	-	-	-
Fat	-	-	-	5+	-	-	-	-	-
Carbohydrate	-	-	-	1,2	-	E,NE	-	NR	-
Calcium	S	-	-	-	B,S	-	NR	-	-
Iron	-	-	-	-	-	-	-	-	-
Magnesium	-	-	-	-	B	E	-	-	-
Phosphorus	-	-	-	-	-	-	-	-	-
Vitamin A	-	-	-	-	S	-	-	-	-
Thiamin	-	-	-	-	W	-	-	-	-
Riboflavin	-	-	-	-	-	-	-	-	-
Niacin	-	NM	-	-	-	-	-	-	-
Vitamin B-6	-	NM	-	3-4,5+	-	-	-	-	-
Vitamin B-12	-	-	-	-	-	-	-	-	-
Vitamin C	NC,S,W	NM	-	5+	-	-	-	-	NR

_ There were no significant differences in nutrient density consumption among categories.

Region was represented by northeast (NE) north central (NC), south (S) and west (W).

Urbanization was represented by central city (CC), suburban (S) and non-metropolitan (NM).

Household Size was represented by 1 member (1), 2 members (2), 3 to 4 members (3-4) and 5 or more members (5+).

Race was represented by white (W), black (B), Spanish (S) and other (O).

Household Head Employment Status was represented by employed (E), not employed (NE) and not reported (NR).

Household Head Education Level was represented by elementary (E), high school (HS), college (C) and not reported (NR).

Table 10. A summary of characteristics of individuals with highest average nutritional quality of diets, United States, Spring, 1977.

Nutrient	Region	Urbanization	Income	Household Size	Race	Employment Status Male	Employment Status Female	Education Level Male	Education Level Female
Protein	-	-	-	-	-	-	-	-	-
Fat	-	-	-	1,2,3-4	-	-	-	-	-
Carbohydrate	-	-	-	3-4,5+	-	NR	-	E,HS,C	-
Calcium	NE,NC,W	-	-	-	O	-	E,NE	-	-
Iron	-	-	-	-	-	-	-	-	-
Magnesium	-	-	-	-	W,S,O	NR	-	-	-
Phosphorus	-	-	-	-	-	-	-	-	-
Vitamin A	-	-	-	-	B,O	-	-	-	-
Thiamin	-	-	-	-	S	-	-	-	-
Riboflavin	-	-	-	-	-	-	-	-	-
Niacin	-	CC,S	-	-	-	-	-	-	-
Vitamin B-6	-	CC,S	-	1,2	-	-	-	-	-
Vitamin B-12	-	-	-	-	-	-	-	-	-
Vitamin C	NE	CC,S	-	1	-	-	-	-	HS,C

- There were no significant differences in nutrient density consumption among categories.

Region was represented by northeast (NE), north central (NC), south (S) and west (W).

Urbanization was represented by central city (CC), suburban (S) and non-metropolitan (NM).

Household Size was represented by 1 member (1), 2 members (2), 3 to 4 members (3-4) and 5 or more members (5+).

Race was represented by white (W), black (B), Spanish (S) and other (O).

Household head Employment Status was represented by employed (E), not employed (NE) and not reported (NR).

Household Head Education Level was represented by elementary (E), high school (HS), college (C) and not reported (NR).

analysis and the LSD tests for the main effects of the socioeconomic factors only and not for the interaction effects. The percent contribution and the nutrient density of nutrient-dense and calorie-dense foods in the diets of these groups are presented in Table 11.

Protein, iron, phosphorus, riboflavin, vitamin B_{12}. Average protein, iron, phosphorus, riboflavin and vitamin B_{12} intakes per 1000 kcal were not significantly affected by any of the socioeconomic factors included in the model. Because none of the socioeconomic groups were significantly different in terms of the average density of diets for these nutrients, no comparisons were made of the percent contribution of nutrient-dense and calorie-dense foods for the groups.

Fat. Average fat density of diets was affected by the size of the household in which individuals resided. Lower fat densities occurred in diets of individuals residing in households with five or more members (Table 9). There were no differences in average individual fat intake per 1000 kcal for the other three household size groups (Table 10), so the average percent contribution of nutrient-dense and calorie-dense foods were computed for these three groups together.

The Fats-Sweets-Alcohol food group accounted for an average of ten percent of the fat consumed by individuals regardless of the size of the household in which the individuals resided (Table 11). The "Basic-Four" food groups which were classified into one nutrient-dense category accounted for the other 90 percent of fat consumed by individuals in households of different sizes. For the group of

Table 11. Percent contribution and nutrient density of nutrient-dense and calorie-dense food groups in the diets of population groups with lowest and highest average nutrient density of diets.

	Average Proportion of Nutrient Consumed from		Average Nutrient Amount per 1000 kcal from	
	Nutrient-Dense Group	Calorie-Dense Group	Nutrient-Dense Group	Calorie-Dense Group
FAT				
Household Size				
Low:				
5 + Members	0.90	0.10	39.49	4.36
High:				
1,2,3-4 Members	0.90	0.10	40.63	4.68
CARBOHYDRATE				
Household Size				
Low:				
1,2 Members	0.82	0.18	84.90	18.29
High:				
3-4, 5+ Members	0.82	0.18	88.38	19.84
Male Head Employment				
Low:				
employed, not employed	0.83	0.17	81.26	16.64
High:				
not reported	0.80	0.20	97.10	24.28
Male Head Education				
Low:				
not reported	0.84	0.16	72.96	13.90
High:				
elementary, high school, college	0.81	0.19	90.80	21.30
CALCIUM				
Region				
Low:				
South	0.96	0.04	360.94	15.04
High:				
Northeast, North Central, West	0.96	0.04	390.36	16.26
Race				
Low:				
Black, Spanish	0.96	0.04	352.70	14.70
High:				
Other	0.96	0.04	446.65	18.61

Table 11. (continued)

	Average Proportion of Nutrient Consumed from		Average Nutrient Amount per 1000 kcal from	
	Nutrient-Dense Group	Calorie-Dense Group	Nutrient-Dense Group	Calorie-Dense Group
Female Head Employment				
Low:				
not reported	.95	.05	329.64	17.35
High:				
elementary, high school, college	.96	.04	410.82	17.12
MAGNESIUM				
Race				
Low:				
black	0.88	0.12	113.41	15.46
white, Spanish, other	0.83	0.17	116.29	23.82
Male Head Employment				
Low:				
employed	0.85	0.15	107.70	19.00
High:				
not reported	0.86	0.14	128.04	20.84
VITAMIN A				
Race				
Low:				
Spanish	0.95	0.05	1805.49	95.03
High:				
black, other	0.94	0.06	3417.35	218.13
THIAMIN				
Race				
Low:				
white	0.99	0.01	0.63	0.01
High:				
Spanish	0.99	0.01	0.73	0.01
NIACIN				
Urbanization				
Low:				
non-metro	0.94	0.06	9.39	0.60
High:				
central city, suburban	0.94	0.06	9.89	0.63

Table 11. (continued)

	Average Proportion of Nutrient Consumed from		Average Nutrient Amount per 1000 kcal from	
	Nutrient-Dense Group	Calorie-Dense Group	Nutrient-Dense Group	Calorie-Dense Group
VITAMIN B-6				
Urbanization				
Low: non-metro	0.98	0.02	0.74	0.02
High: central city, suburban	0.98	0.02	0.78	0.02
Household Size				
Low: 3-4,5+ Members	0.98	0.02	0.73	0.01
High: 1,2 Members	0.98	0.02	0.81	0.02
VITAMIN C				
Region				
Low: north central, south, west	0.92	0.08	42.07	3.66
High: northeast	0.93	0.07	48.72	3.67
Urbanization				
Low: non-metro	0.92	0.08	40.68	3.54
High: central city, suburban	0.92	0.08	45.48	3.96
Household Size				
Low: 5+ Members	0.92	0.08	37.38	3.70
High: 1 Member	0.92	0.08	52.22	4.54
Female Head Education				
Low: not reported	0.93	0.07	41.22	3.10
High: high school, college	0.94	0.06	49.08	3.13

individuals with highest average fat density of diets, i.e., those residing in households with one to four members, the concentration of fat was higher in foods from both nutrient-dense and calorie-dense food groups when compared to corresponding values for the household size group with lowest average fat density of diets.

Carbohydrate. Average carbohydrate density of diets was significantly affected by household size, employment status and educational attainment of the male head of the household.

Individuals residing in households with one or two members had the lowest average carbohydrate intake per 1000 kcal when compared with intakes of individuals in larger households (Tables 9-10). The calorie-dense and nutrient-dense food groups contributed averages of 18 and 82 percent, respectively, of carbohydrate to the diets of individuals regardless of whether they were in the group with lowest or highest carbohydrate quality of diets (Table 11). Individuals in the group with higher carbohydrate density of diets, i.e., residents of households with three or more members, consumed foods with higher concentrations of carbohydrate in both the calorie-dense and the nutrient-dense categories when compared to the group with lower carbohydrate density of diets.

Average carbohydrate intake per 1000 kcal was higher among the group of individuals for whom the employment status of the male head of the household was not reported when compared to individuals residing in households with reported male head employment status (Tables 9-10). Average carbohydrate density of diets were statistically equivalent for the latter group regardless of whether or not the male head was reported to be employed or not employed. The average percent contribution of nutrient-dense and calorie-dense foods were reported for the "employed" and "not-employed" groups together and compared with the "not reported" category. The group with the higher carbohydrate density of diets, i.e., the "not reported" group, consumed slightly larger proportion of carbohydrate from the Fat-Sweets-Alcohol foods in comparison to the lower carbohydrate density consumed (Table 11). Also, the average nutrient density of foods in both the nutrient-dense and calorie-dense food groups was greater for individuals in the "not reported" or higher category.

The average carbohydrate density of foods consumed was lower for the group of individuals residing in households in which the education level of the male head was not reported (Table 9) as compared with the group with an elementary, high school or college educated male head (Table 10). Carbohydrate density of diets was equivalent for these last three groups, so the average contributions of the two food groups for these three education categories were compared with corresponding values for the "not reported" category. The group with the higher average carbohydrate density of diets obtained a greater proportion (0.19) of carbohydrate from the calorie-dense food group as compared with the proportion (0.16) for the group of individuals consuming lower carbohydrate intakes on a calorie basis (Table 11). The nutrient density of the foods in both the nutrient and calorie-dense food groups was greater for the high carbohydrate density consumers.

Calcium. Average calcium intake on a nutrient density basis was significantly affected by geographic region, race and employment status of the female head of the household.

Lower calcium density of diets occurred in the southern region (Table 9) as compared with the other three regions, which were equivalent in terms of calcium consumption on a calorie basis (Table 10). The calorie-dense food group, Fats-Sweets-Alcohol, accounted for an average of four percent of the calcium consumed regardless of the geographic location of the individual's place of residence (Table 11). However, for the group with the higher average calcium density of diets, i.e., those residing in the northeast, north central and west, the nutrient density or concentration of calcium was higher in foods in both calorie-dense and nutrient-dense categories.

The group of black and Spanish individuals averaged diets with the lowest amount of calcium per 1000 kcal (Table 9), whereas the group of white individuals consumed diets with the highest average calcium densities (Table 10). The percent contribution of calcium from the nutrient-dense and calorie-dense food groups was 96 percent and four percent, respectively, for both the high (white) consumers and the low (black, Spanish) consumers of calcium on a nutrient density basis (Table 11). The nutrient density of the foods consumed in the Fat-Sweet-Alcohol group and the other "Basic-Four" nutrient-dense group was higher for the group of white individuals as compared with the group of black and Spanish individuals.

Results of the multiple regression and LSD analysis indicated that average calcium density of diets was lower in households where the employment status of the female head was not reported (Table 9) and higher and equivalent for other individuals regardless of whether or not the female head was employed outside the home (Table 10). The "not reported" group, i.e., the group with the lower average calcium density of diets, consumed approximately the same proportion of calcium from the calorie-dense food group when compared with the employed/not employed group (Table 11). However, the average calcium density of the calorie-dense foods consumed by the "not-reported" group was lower than for comparable foods consumed by the employed/not employed group. The calcium density of foods consumed from nutrient-dense foods was also lower for the "not-reported" category when compared with the employed/not employed group.

Magnesium. Average magnesium density of diets was affected by race and employment status of the male head of the household. Lower average magnesium consumption per 1000 kcal occurred among the group of black individuals (Table 9) with the whites, Spanish and "others" having higher and equivalent intakes of magnesium on a calorie basis (Table 10). Comparisons of the average percent contribution of nutrient-dense and calorie-dense foods were made for the black group versus the average for the other three groups. The percent contribution of calorie-dense foods to magnesium intake was lower for the black group (12%) as compared to the average of the white, Spanish and other groups (17%) (Table 11). The average magnesium density of foods consumed by blacks was lower than the average of the other three groups in both the calorie-dense and nutrient-dense food groups.

For subgroups in the male head employment category magnesium intake per 1000 kcal was lowest among the group of individuals residing in households in which the male head of the household was employed (Table 9) and highest in households where the male head employment status was not reported (Table 10). The percent of magnesium contributed by the calorie-dense and nutrient-dense food groups were approximately the same for these two groups despite differences in the average magnesium quality of their diets (Table 11). For the group with the highest magnesium density, i.e., the "not reported" category, the concentration of magensium was higher in foods consumed from both food groups when compared to corresponding values for the black group, which consumed the lowest average amount of magnesium per 1000 kcal.

Vitamin A. Results of the nutrient density consumption analysis indicated that vitamin A intake per 1000 kcal was significantly different for the different race/ethnic groups. Lowest average vitamin A intake on a calorie basis occurred among Spanish individuals (Table 9), whereas blacks and "others" had the highest consumption of vitamin A per 1000 kcal (Table 10). The Spanish group was compared with the average of the black and "other" categories with respect to the contribution of nutrient-dense and calorie-dense to the diets of these ethnic groups. The calorie-dense Fats-Sweets-Alcohol, food group contributed about the same percentage of dietary vitamin A for both groups regardless of the differences in average vitamin A quality of diets (Table 11). However, vitamin A density of foods consumed from both food groupings was higher for the black/others group. The average vitamin A density of foods in the nutrient-dense food group was almost 90 percent higher in the black/other group than in the Spanish group.

Thiamin. Thiamin density of diets were also signficantly affected by race, with whites having the lowest average thiamin intakes per 1000 kcal (Table 9) and Spanish individuals having the highest thiamin density of diets (Table 10). The nutrient-dense foods consumed by individuals in both the white and Spanish categories contributed 99 percent of the thiamin content of diets (Table 11). The thiamin density of the nutrient-dense foods consumed by the Spanish group averaged higher thiamin content (0.73 mg) per 1000 kcal when compared with the thiamin density (0.63 mg/1000 kcal) of nutrient-dense foods consumed by the group of white individuals.

Niacin. Results of the nutrient density statistical analysis indicated that preformed niacin intake per 1000 kcal was significantly affected by the degree of urbanization of the individual's place of residence. Average niacin density of diets was lower in non-metropolitan areas (Table 9) when compared to central city and suburban areas (Table 10). The nutrient-dense food group accounted for an average of 94 percent of the preformed niacin consumed per 1000 kcal by individuals in non-metropolitan areas and central city/suburban areas alike (Table 11). For the group with the higher niacin density of diets, i.e., those in central city and suburban areas the concentration of preformed niacin was higher in foods from both food groupings when compared to corresponding values for the non-metropolitan group.

Vitamin B_6. Average vitamin B_6 density of diets was significantly affected by urbanization level and size of the household in which individuals resided. Individuals residing in non-metropolitan areas had significantly lower vitamin B_6 quality of diets when compared with individuals in central city and suburban areas (Tables 9-10). The calorie-dense food group contributed an average of 98 percent of vitamin B_6 to the diets of individuals regardless of whether they were in the group with lowest or highest vitamin B_6 quality of diets. The nutrient density of foods in the calorie-dense group were the same for high and low consumers of vitamin B_6 per 1000 kcal. However, the concentration of vitamin B_6 was slightly higher in nutrient-dense foods consumed by individuals with the highest vitamin B_6 quality of diets, i.e., those individuals residing in central city and suburban areas.

Individuals residing in households with only one or two members consumed diets with significantly higher vitamin B_6 content per energy unit, when compared with individuals residing in larger households (Tables 9-10). The average percent contribution of foods from the nutrient-dense (98%) and calorie-dense (2%) foods was the same for both the higher consumers (household size: 1-2) of vitamin B_6 per 1000 kcal and the lower consumers (household size: 3 or more). The nutrient density of foods consumed in the Fat-Sweet-Alcohol Group and the other "Basic-Four" nutrient-dense group was higher for the group of individuals residing in households with only one or two household members, which was the group with highest average vitamin B_6 quality of diets.

<u>Vitamin C</u>. Average vitamin C intake on a nutrient density basis was significantly affected by geographic region, urbanization level, household size and the education level of the female head of the

household.

Higher vitamin C density of diets was found in the northeastern region (Table 9) as opposed to the other three regions, which were equivalent in terms of vitamin C consumption on a calorie basis (Table 10). The nutrient-dense foods consumed by these two groups (northeast vs. north central/south/west) accounted for an average of 92 to 93 percent of vitamin C consumed per 1000 kcal (Table 11). For the group (northeast) with the higher average vitamin C density of diets, the concentration of vitamin C was higher in foods in the nutrient-dense food group.

Average vitamin C density of diets was lower in non-metropolitan areas when compared with central city and suburban areas (Tables 9-10). The nutrient-dense food group accounted for an average of 92 percent of the vitamin C consumed per 1000 kcal by individuals in both non-metropolitan and central city/suburban areas (Table 11). For the group with the high vitamin C density of diets, i.e., those in central city and suburban areas, the concentration of vitamin C was higher in foods from both food groupings when compared to corresponding values for the non-metropolitan group.

Lowest average vitamin C densities of diets of individuals in different household sizes occurred for the group of individuals residing in households with five or more members (Table 9). Highest average vitamin C intake per 1000 kcal was in single-person households (Table 10). The Fats-Sweets-Alcohol food group accounted for an average of eight percent of the vitamin C consumed by individuals in these two household size groups despite differences in the average vitamin C quality of their diets (Table 11). Individuals in the group with the highest vitamin C density of diets, i.e., single-person households, consumed foods with higher average concentrations of vitamin C in both the nutrient-dense and calorie-dense food groups, in comparison to diets of the group with lowest vitamin C density of diets.

In the female head education category, the average vitamin C density of foods consumed was lowest for the group of individuals residing in households in which the education level of the female head was not reported and was highest for the group with a high school or college educated female head (Tables 9-10). Vitamin C density of diets was equivalent for the high school and college educated groups, so the average contributions of the two food groupings for these two education categories were compared with corresponding values for the "not reported" category. The group with the highest average vitamin C density of diets obtained approximately the same proportion of vitamin C from the calorie-dense food groups as did the group of individuals consuming lower vitamin C intake on a calorie basis (Table 11). The vitamin C density of the foods in the nutrient-dense category was greater for the high vitamin C density consumers.

DISCUSSION

Purpose of the Study

The purpose of this study was to evaluate the nutrient density concept for analysis of food consumption survey data. Nutrient density analysis was used to specify relationships between socioeconomic characteristics of population groups and the nutrient density of their diets. Comparisons were made of average nutrient density of diets with nutrient density standards to obtain a measure of the nutritional quality of diets. The contribution of nutrient-dense and calorie-dense foods to the diets of selected population groups was also determined. The effectiveness and appropriateness of the nutrient density approach for the analysis of food consumption data was evaluated.

Methods and Procedures

Data from 7285 individual participants in the USDA Spring Nationwide Food Consumption Survey were analyzed using the nutrient density concept and multiple regression procedures to evaluate the impact of socioeconomic status on the nutritional quality of foods consumed. For each individual, the average daily amount of nutrients consumed per 1000 kcal of food consumed were computed from the nutritive value data. Values per 1000 kcal were determined for protein, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, preformed niacin, vitamins B_6, B_{12} and C. Multiple linear regression analysis and Fisher's LSD test were used to determine the effect of selected socioeconomic factors upon nutrient density consumption patterns. Socioeconomic factors considered were geographic region, degree of urbanization, income, race, household size, employment status and educational attainment of the male and female heads of households. The Index of Nutritional Quality was computed for each nutrient and comparison was made of INQ values for the socioeconomic groups which had statistically different nutrient density consumption based upon the statistical analysis. The percent contribution and nutrient density of foods from calorie-dense and nutrient-dense foods were also determined for these population groups.

Major Findings

Results of this study were used to identify the effects of selected socioeconomic factors on qualitative patterns of food consumption. Results indicated that income level had no statistically significant effect upon the nutritional quality of diets with respect to the 14 nutrients included in the analysis. Household size was significantly related to nutrient density consumption of fat, carbohydrate, vitamin B_6 and vitamin C. Race affected calcium, magnesium, vitamin A and thiamin density of diets. Geographic region was significantly related to differences in calcium and vitamin C consumption per 1000 kcal and degree of urbanization had an effect on niacin, vitamin B_6 and vitamin C intakes on a nutrient density basis. Employment status and level of education of the male and female heads of households were significantly related to nutrient density consumption of one or two nutrients. The major differences for these groups occurred between the "not reported" category and the categories for which employment status or educational attainment was reported. Standard errors of mean consumption were relatively large for all of the "not reported" categories because the sample sizes were smaller than for the other categories. The results of the comparisons which included a "not reported" group were based upon the best information that was available, but, it was not possible to accurately interpret these data without knowing the characteristics of individuals causing the results observed.

Vitamin C was the nutrient most frequently affected by socioeconomic factors which were included in the model. Average vitamin C intake on a nutrient density basis was significantly related to geographic region, urbanization level, household size and education level of the female head of the household. Carbohydrate density of diets was affected by household size, employment status and education level of the male head of the household. Fat, calcium, magnesium, vitamin A, thiamin, niacin and vitamin B_6 intakes per 1000 kcal were significantly affected by only one or two socioeconomic factors. Protein, iron, phosphorus, riboflavin and vitamin B_{12} densities were not related to any of the socioeconomic variables included in the model.

For the socioeconomic categories with statistically different nutrient density intakes the relative percent contribution of nutrient from the calorie-dense and nutrient-dense food groupings was the same or very similar for all subgroups of the socioeconomic category. The nutrient density of foods consumed in both the nutrient-dense and calorie-dense groups or in the nutrient-dense group alone was higher for the population subgroups with higher average nutrient density of diets. In other words, the differences in average nutrient density of diets resulted from differences in the quality of foods consumed from both the nutrient-dense and calorie-dense groups and not from differences in the percent contribution of these two food groups to nutrient intake per 1000 kcal. There were two exceptions to this result. Differences in magnesium intake per 1000 kcal for the race categories were due to differences in the quality of foods from both food groups and also in the percent contribution of magnesium from these two groups. The other exception was fat quality of diets for the male household head employment and education categories. The groups with high average fat density of diets consumed foods with higher fat concentrations in both food groups and they also obtained a greater proportion of the fat content of their diet from foods in the calorie-dense group. In this case, the differences were between the "not reported" categories and the other categories of the employment and education factors, again making it difficult to draw any viable conclusions.

Average diets for all socioeconomic groups were below nutrient density standards for calcium, iron, magnesium, vitamin B_6 and carbohydrate. There was also a high frequency of vitamin A and vitamin C intakes below nutrient density standards despite adequate group mean intakes per 1000 kcal for these nutrients.

Discussion

The results of this study indicated that a number of socioeconomic characteristics of individuals and households influenced the average nutritional quality of diets consumed with respect to a limited number of nutrients. The nutritional quality of diets did not vary with income level, indicating that individuals with lower incomes may select good quality, less costly foods to meet their dietary needs. This apparent efficiency may result in part from the food programs of the past ten years which have assisted the lower income groups so that they more nearly participate in the food supply. This outcome may also be partially the result of nutrition education programs that have been aimed at low income households.

Geographic region of the place of residence and race were significant factors affecting calcium density of diets. Individuals residing in the south consumed signficantly lower amounts of calcium on a nutrient density basis. It is possible that lower calcium density of diets in the south could be attributed to the greater proportion of Black individuals in the southern region of the survey sample. Blacks, along with Spanish individuals, consumed diets with significantly lower calcium per 1000 kcal than did other race or ethnic groups.

In the past few years, evidence has accumulated which indicate that a large percentage of non-caucasian adults have low levels of lactase, which is needed to convert the milk sugar lactose to glucose and galactose so it can be absorbed. As a result, these adults are unable to tolerate any appreciable amount of lactose without developing gastrointestinal symptoms. Observations have also been made that black children who may have a lactase defect consume less milk than white children, presumably because of the discomfort associated with the ingestion of milk. Individuals with lactose intolerance are able to consume fermented milks and cheese and also appreciable amounts of milk if it is introduced in slowly increasing amounts over a period of time. Since milk is the major source of dietary calcium, riboflavin and often of protein it seems desirable to educate Black and Spanish individuals, particularly in the South, to some of the alternatives for obtaining calcium without lactose.

The degree of urbanization the place of residence was associated with differences in preformed niacin, vitamin B_6 and vitamin C intakes on a calorie basis. For each of these nutrients, consumption per 1000 kcal was lowest in non-metropolitan areas. Niacin intakes averaged about 50 percent above nutrient density standards and the proportion of individuals with intakes below standard was less than 0.10 for all urbanization levels. The niacin which is available from tryptophan in protein is probably sufficient to elevate the total niacin value of most diets to standard level. Given that preformed niacin and protein are consumed in rather generous amounts in the United States, niacin does not appear to be a nutrient of general concern.

Average vitamin B_6 intake per 1000 kcal was below standard for all socioeconomic groups. Individuals residing in non-metropolitan areas and in households with three or more members had significantly lower intakes when compared with other groups in their respective socioeconomic categories. This evaluation must be considered tentative, however, because of the limited data available on food composition and on human requirement for vitamin B_6. The calculated content of vitamin B_6 for these diets is based upon the best information currently available, but the reliability is less certain than for many other nutrients.

The adequacy of vitamin B_6 on a calorie basis was measured relative to a standard of one milligram per 1000 kcal which is based upon the RDA of approximately 2.0 to 2.2 mg per day for adults. A ratio of 0.02 mg of vitamin B_6 per gram of protein has also been suggested by the Food and Nutrition Board as a basis for calculating the vitamin B_6 allowance. When this value is used to determine vitamin B_6 adequacy based upon an average value of 40 grams of protein per 1000 kcal reported as consumed in this study, diets appear to be far closer to meeting recommended standards for vitamin B_6.

Vitamin C intake on a calorie basis was affected by more socioeconomic variables than any other nutrient included in the study. Average vitamin C intakes per 1000 kcal was significantly lower in non-metropolitan areas when compared with other urbanization levels and higher in the northeast when compared to other regions. Results of the 1965-1966 Household Food Consumption Survey indicated that urban households and households in the northeast used more fruits and vegetables per person than did non-urban households. Food intake data for households and individuals broken down by region and urbanization levels are not yet available from the 1977-1978 survey.

Vitamin C intake on a calorie basis was also associated with variables representing household size and education level of the female head of the household. The reason for differences in vitamin C density of diets between individuals residing in one or two person households and those in larger households is not clear. Few children were in the one and two person family units and this may have had an effect on the average vitamin C quality of diets. Individuals residing in households in which the female head had a high school or college education consumed greater quantities of vitamin C on a nutrient density basis than those residing in households where the female head had only elementary schooling. It is assumed that this difference is due to a greater awareness and concern about nutrition and health among better educated homemakers and the influence on these individuals of the publicized theoretical benefits of vitamin C in promoting health and preventing disease.

Values for vitamin C and for vitamin A consumption per 1000 kcal averaged 50 percent above nutrient density standards, indicating that these are not nutrients of concern. However, the percentage of individuals with diets below standard were as high as 40 percent for vitamin C and 50 percent for vitamin A. One of the major problems with the evaluation of dietary vitamins A and C status from survey data results from the distribution of these nutrients in the food supply. Vitamin A and vitamin C are generally found in relatively high concentrations in a limited number of foods. As Americans tend to vary their diets tremendously from one day to the next, the day-to-day variation in vitamins A and C consumed may be substantial depending upon whether or not good sources of these nutrients were consumed. Survey data which account for only two or three days of food consumption may not give an accurate estimate of individual dietary status with respect to these two nutrients. In this case, mean values, because they represent intake averaged over a large number of individuals, may provide a more meaningful reflection of vitamins A and C intake status for groups of people, than do median values or estimates of the percentage of individuals with intake levels below standard.

One situation where vitamin A density may be of particular concern is in the diets of individuals of Spanish origin. Results of the Ten-State Nutrition Survey indicated that vitamin A status was poor among Mexican-Americans living in Texas, although vitamin A status among Puerto Ricans living in the New York City area did not appear to be a problem. Results of this study indicated that the vitamin A quality of foods consumed by the group of Spanish individuals was significantly lower than that of other race or ethnic groups. This was the only situation in the study where differences in mean nutrient density intake between categories resulted from one group having intakes below standard whereas other groups exceeded the standard. Vitamin A intake per 1000 kcal for white and black individuals averaged 46 to 88 percent higher than for those of Spanish origin.

Average magnesium density of diets were also affected by race, Blacks consumed significantly less of magnesium per 1000 kcal than did other race or ethnic groups. Mangesium occurs widely in foods, particularly those of vegetable origin, and magnesium deficiency is usually seen only in pathological conditions such as malabsorption syndromes and gastrointestinal tract diseases. As with vitamin B_6, food composition data for magnesium are still somewhat tentative. The calculated content of magnesium in diets and estimates of human requirements for this mineral are less certain than for other nutrients.

The results of the statistical analysis indicated that fat and carbohydrate density of diets of individuals residing in households of different sizes may be negatively correlated. Individuals residing in households with five or more members had lower average fat consumption per 1000 kcal and, along with individuals residing three to four member household, had higher carbohydrate intake per 1000 kcal when compared to residents of smaller households. These differences may be due to lower consumption in larger households of high fat food items such as meat and whole milk products which are also relatively expensive items. For whatever reason, individuals residing in larger household appeared to be substituting carbohydrate sources for fat sources in order to meet their energy needs.

The average consumption of fat on a calorie basis was above nutrient density standards for all population groups, with only about 20 percent of the population consuming diets below the recommended level of 35 percent of energy as fat. The opposite pattern was indicated for carbohydrate density of diets. Average consumption of carbohydrate was below nutrient density standards for all groups, with as high as ninety percent of the population consuming diets below the obviously elusive goal of 58 percent of calories from carbohydrate sources.

The results of the analysis for the employment status and education level of the male and female heads of the households were confounded by the significant effects of the "not reported" categories within these factors. For most nutrients which were significantly affected by these factors, differences in average nutrient density of diets were between the not reported categories and the other categories. The analysis and the interpretation of the effects of these factors on nutrient density obviously would have been enhanced if individuals in the not reported groups could have been further characterized. The only viable conclusion regarding these data is that, where information is known concerning the employment status and educational level of the heads of households, there are no significant effects of these factors upon the nutrient density of diets consumed by individual household members. The one exception in the study was the association between vitamin C intake per 1000 kcal and education level of the female head of the household, which was discussed earlier.

The statistical analysis which was used in this study was designed to detect differences in the nutrient density of diets and these differences have been emphasized in the presentation of the results and discussion. Overall, however, very few differences were observed. The analysis tested the effects of nine main factors on the consumption of fourteen nutrients or a total of 126 relationships. Of these, only 18 were statistically significant. If one takes into consideration the problems with the education and employment factors and the concerns about the reliability of the magnesium and vitamin B_6 and perhaps the niacin data, even fewer associations may be considered significant.

The effect of the relatively large sample size in this analysis was to make small differences in nutrient intake per 1000 kcal appear statistically significant. A one percent difference may be significant at the 0.001 level if the sample is large enough, yet a small difference may be essentially meaningless in terms of practical interpretation and application. Conversely, a large difference that is not significant at the five percent level, simply because it is based upon a small sample, may be of major practical importance. A resulting difficulty is the confusion of statistical significance with substantive importance.

An example in this study is the statistical significance (at the 0.01 level) of the relationship between household size and fat intake per 1000 kcal which was emphasized earlier in the discussion. The largest difference in average fat density of diets for any of the household size groups was two grams per 1000 kcal. Such small statistically significant differences may well be unimportant in terms of practical applications. Similar conclusions can be made for other relationships which were significant in this study. The emphasis upon problems of the statistical results of this study is not meant to diminish the importance of differences where they do exist, but rather to put the results into a realistic and practical perspective.

Summary and Conclusions

The analysis of food consumption survey data provides baseline information for a variety of purposes including the development of nutrition education messages, nutrition labeling and fortification policies and estimation of human nutrient requirements. In this study the concept of nutrient density was applied to the analysis of recent food consumption data for the United States. The ultimate goal of such an analysis is to better understand what the American public is eating and what implications this may have for national health.

Results of this study indicated that regardless of socioeconomic status, Americans consume diets that average very similar nutrient content per energy unit. In other words, Americans appear to be consuming from a "common table", with some eating more and some less of the same basic foods. Despite this general consistency in nutritional quality patterns, there are some areas of concern. The calcium density of diets in the southern region and among black individuals and the vitamin A density of diets of Spanish individuals continue to be a problem. The significance of the nutrient density concept is that it identifies the degree to which nutritional adequacy of these diets is either a quantitative function of the total amount of food consumed or is dependent upon specific choices of foods with high nutrient content. The solution to nutritional problems of identified high-risk groups may not be more food but rather in better quality food.

Application of the nutrient density concept to the analysis of food consumption data allows the evaluation of the potential of foods consumed to meet nutritional goals. Other measures such as comparing amounts of nutrients consumed with the Recommended Dietary Allowances, indicate the degree to which individuals or groups meet a recommended level of nutrient intake. The nutrient density concept as a supporting measure indicates the degree of balance of the different nutrients in the diet. Patterns of nutrient consumption can be easily identified and the effect of various population characteristics on these patterns can be readily evaluated.

Recommendations

The general sedentary lifestyle in the United States makes it necessary for Americans to carefully balance nutrient and energy intakes. Where nutritional problems exist, it may be more beneficial in terms of overall health, to encourage substitution of nutrient-dense foods to meet specific needs, rather than simply emphasizing higher consumption levels of specific nutrients. Directing nutritional programs toward identified high-risk groups may be an effective means of dietary improvement. However, all segments of the population could benefit from a more general approach. Average diets should have a quality that meets the nutrient requirements of most individuals in the population.

Planning diets using the recommended nutrient density standards to compute safe nutrient densities for all ages would enable almost everyone to obtain an adequate supply of nutrients while consuming energy according to needs. This type of planning may be increasingly important in affluent countries, such as the United States, where trends in lifestyle appear to be moving in a direction which decreases the need for energy. A constructive national goal would be to aim at improving the food habits of the entire population so that individuals with low consumption of calories would obtain adequate quantities of all essential nutrients. Achievement of such a goal would necessarily involve a coordinated effort by government, the food industry and the nutrition community.

The uniformity of nutrient consumption patterns of socioeconomic groups described in this study supports arguments in favor of the nutrient density approach to nutrition education and evaluation. The concept of nutrient density and nutrient density standards can provide useful guidelines for developing national food and nutrition policies and education programs, for evaluation of new products by the food industry and for helping consumers to make appropriate food choices.

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APPENDICES

Appendix A

Coding Scheme for Indicator Variables in Linear Model

Coding Scheme for Indicator Variables in Linear Model

U_1 - U_2 = degree of urbanization of the place of residence, with

U_1 = 1 if central city

= 0 if suburban

= -1 if non-metro

U_2 = 0 if central city

= 1 if suburban

= -1 if non-metro

G_1 - G_3 = geographic location of the place of residence, with

G_1 = 1 if northeast

= -1 if west

= 0 otherwise

G_2 = 1 if north central

= -1 if west

= 0 otherwise

G_3 = 1 if south

= -1 if west

= 0 otherwise

R_1 - R_2 = race or ethnic origin of the individual, with

R_1 = 1 if White

= -1 if unknown or not reported

= 0 otherwise

R_2 = 1 if Black

= -1 if unknown or not reported

= 0 otherwise

R_3 = 1 if Spanish

= -1 if unknwon or not reported

= 0 otherwise

$I_1 - I_6$ = annual income of the household, with

I_1 = 1 if less than \$5,000

= -1 if not reported

= 0 otherwise

I_2 = 1 if \$5,000 - 9,999

= -1 if not reported

= 0 otherwise

I_3 = 1 if \$10,000 - 14,999

= -1 if not reported

= 0 otherwise

I_4 = 1 if \$15,000 - 19,999

= -1 if not reported

= 0 otherwise

I_5 = 1 if \$20,000 - 24,999

= -1 if not reported

= 0 otherwise

I_6 = 1 if \$25,000 - or more

= -1 if not reported

= 0 otherwise

$N_1 - N_3$ = number of individuals in a household, with

N_1 = 1 if one member

= -1 if five or more members

= 0 otherwise

N_2 = 1 if two members

= -1 if five or more members

= 0 otherwise

N_3 = 1 if three or four members

= -1 if five or more members

= 0 otherwise

$M_1 - M_2$ and $F_1 - F_2$ = employment status of the male (M) and female (F) heads of the household during the week preceding the survey interview, with

M_1 or F_1 = 1 if employed

= 0 if not employed

= -1 if unknown/not reported

M_2 or F_2 = 1 if not employed

= 0 if employed

= -1 if unknown/not reported

$E_1 - E_3$ and $D_1 - D_3$ = level of education attained by the male (E) and female (D) heads of the household, with

E_1 or D_1 = 1 if elementary school or less

= -1 if not reported

= 0 otherwise

E_2 or D_2 = 1 if at least some high school

= -1 if not reported

= 0 otherwise

E_3 or D_3 = 1 if at least some college

= -1 if not reported

= 0 otherwise

$A_1 - A_7$ = age in years of the individual, with

A_1 = 1 if 4-6 years

= -1 if 65 years or older

= 0 otherwise

A_2 = 1 if 7-10 years

= -1 if 65 years or older

= 0 otherwise

A_3 = 1 if 11-14 years

= -1 if 65 years or older

= 0 otherwise

A_4 = 1 if 15-18 years

= -1 if 65 years or older

= 0 otherwise

A_5 = 1 if 19-22 years

= -1 if 65 years or older

= 0 otherwise

A_6 = 1 if 23-50 years

= -1 if 65 years or older

= 0 if otherwise

A_7 = 1 if 51-64 years

= -1 if 65 years or older

= 0 if otherwise

S = gender of the individual, with

S = 1 if male

= -1 if female

Appendix B

Analysis of Covariance in the Nutrient Density Consumption Linear Model

Source of Variation	Degrees of Freedom	Vitamin B_6 mean square	p	Vitamin B_{12} mean square	p	Vitamin C mean square $\times 10^3$	p
Region	3	0.04	0.621	15.4	0.608	6.36	0.001
Urbanization	2	0.60	0.000	57.6	0.103	6.10	0.007
Income	6	0.06	0.514	13.8	0.773	3.05	0.020
Household Size	3	0.49	0.000	71.8	0.037	5.11	0.006
Race/Ethnicity	3	0.09	0.227	17.0	0.568	4.13	0.017
Employment Male Head	2	0.00	0.987	36.0	0.241	0.54	0.639
Employment Female Head	2	0.01	0.813	10.3	0.664	0.85	0.498
Education Male Head	3	0.04	0.596	43.3	0.162	3.64	0.030
Education Female Head	3	0.06	0.454	4.7	0.900	4.88	0.007
Sex	1	0.06	0.727	14.38	0.999	2.33	0.000
Age	7	0.19	0.003	19.82	0.601	5.37	0.000
Covariates							
Height	1	0.02	1.000	0.89	1.000	0.70	0.998
Weight	1	0.03	0.999	154.87	0.000	3.27	0.000
2-way Interactions							
Age & Sex	7	0.16	0.014	12.57	0.837	4.04	0.002
Region by Urbanization	6	0.13	0.049	22.55	0.500	0.79	0.688
Income & Household	18	0.09	0.099	19.19	0.750	2.38	0.009
Residual	2376	0.06		25.28		1.22	
Total	2444	0.07		25.31		1.36	

Source of Variation	Degrees of Freedom	Magnesium mean square X 10^3	p	Phosphorus mean square X 10^4	p	Vitamin A mean square X 10^7	p	Thiamin mean square	p	Riboflavin mean square	p	Niacin mean square	p
Region	3	4.01	0.024	4.29	0.064	1.39	0.382	0.06	0.237	0.08	0.612	12.24	0.001
Urbanization	2	0.62	0.614	0.75	0.655	5.70	0.015	0.08	0.134	0.23	0.172	64.92	0.001
Income	6	2.84	0.038	4.08	0.032	0.74	0.777	0.04	0.478	0.12	0.486	5.19	0.771
Household Size	3	4.15	0.021	6.21	0.015	4.30	0.024	0.02	0.701	0.28	0.086	20.52	0.089
Race/Ethnicity	3	7.84	0.000	5.45	0.027	6.76	0.002	0.26	0.000	0.06	0.732	2.97	0.815
Employment Male Head	2	7.31	0.003	1.71	0.381	2.24	0.194	0.02	0.610	0.08	0.527	5.15	0.797
Employment Female Head	2	1.29	1.000	3.38	0.149	0.83	0.544	0.06	0.247	0.23	0.165	3.92	0.660
Education Male Head	3	2.41	0.129	4.34	0.062	2.60	0.126	0.03	0.583	0.18	0.242	7.21	0.515
Education Female Head	3	5.02	0.008	5.09	0.035	1.45	0.364	0.03	0.483	0.09	0.534	0.95	0.960
Sex	1	0.00	1.000	0.00	1.000	0.42	1.000	0.03	0.994	0.04	1.000	1.74	1.000
Age	7	22.45	0.000	3.08	0.096	2.94	0.035	0.14	0.001	1.12	0.000	0.67	0.000
Covariates Height	1	3.26	0.000	2.05	0.175	0.03	1.000	0.01	1.000	0.03	1.000	21.50	0.000
Weight	1	7.85	0.000	0.37	1.000	4.54	0.000	0.33	0.000	0.04	1.000	75.82	0.000
2-way Interactions Age & Sex	7	4.29	0.001	2.09	0.310	1.41	0.402	0.09	0.043	0.20	0.150	12.17	0.253
Region by Urbanization	6	3.15	0.022	3.24	0.089	1.42	0.395	0.05	0.317	0.05	0.885	6.85	0.630
Income & Household Size	18	2.10	0.042	3.21	0.019	1.52	0.333	0.07	0.025	0.16	0.212	19.11	0.007
Residual	2376	1.27		1.77		1.36		0.04		0.13		9.45	
Total	2444	1.56		1.84		1.41		0.04		0.14		10.20	

Source of Variation	Degrees of Freedom	Kilocalories Mean square $\times 10^5$	p	Protein mean square $\times 10^2$	p	Fat mean square $\times 10^2$	p	Carbohydrate mean square $\times 10^3$	p	Calcium mean square $\times 10^4$	p	Iron mean square	p
Region	3	8.28	0.079	0.41	0.720	1.31	0.081	1.03	0.084	15.68	0.000	5.45	0.143
Urbanization	2	1.20	0.720	2.32	0.078	1.58	0.066	2.06	0.012	1.00	0.665	9.80	0.039
Income	6	8.90	0.024	0.75	0.550	0.61	0.391	1.01	0.042	4.95	0.059	6.43	0.046
Household Size	3	2.12	0.629	1.86	0.107	2.74	0.003	2.31	0.002	4.05	0.174	9.42	0.025
Race/Ethnicity	3	7.21	0.116	3.22	0.014	1.93	0.019	0.45	0.409	13.87	0.001	6.11	0.107
Employment Male Head	2	29.41	0.000	1.00	1.000	2.45	0.016	2.44	0.005	0.15	0.940	0.60	0.821
Employment Female Head	2	7.31	0.136	0.14	0.855	1.19	0.130	1.20	0.076	13.48	0.004	1.19	0.674
Education Male Head	3	1.59	0.728	1.49	0.179	1.84	0.024	1.89	0.007	8.52	0.015	4.96	0.176
Education Female Head	3	8.37	0.077	8.24	0.965	0.42	0.539	0.31	0.566	8.56	0.015	4.58	0.207
Sex	1	58.26	0.000	6.29	1.000	0.64	0.259	0.47	0.405	0.34	1.000	2.22	0.950
Age	7	39.19	0.000	3.63	0.000	1.12	0.062	4.43	0.000	32.40	0.000	20.60	0.000
Covariates Height	1	58.99	0.000	2.37	0.000	0.04	1.000	0.07	1.000	5.02	0.000	0.43	1.000
Weight	1	1.20	0.567	20.32	0.000	5.19	0.000	15.87	0.000	5.76	0.000	4.85	0.001
2-way Interactions Age & Sex	7	28.56	0.000	1.58	0.097	0.42	0.649	0.31	0.699	3.25	0.231	4.81	0.131
Region by Urbanization	6	6.13	0.123	2.59	0.009	1.81	0.005	1.64	0.002	5.93	0.024	2.41	0.569
Income & Household Size	18	3.69	0.446	0.98	0.374	0.60	0.413	0.78	0.038	3.88	0.054	3.21	0.381
Residual	2376	3.66		0.91		0.58		0.46		2.44		3.01	
Total	2444	5.14		0.98		0.63		0.55		2.81		3.27	

Appendix C

Adjusted Mean Kilocalorie and Nutrient Intakes per 1000 Kcal, Standard Errors, Medians and Percent Individuals Below Recommended Nutrient Density Standards

KILOCALORIE INTAKE

Variable	Adjusted Mean	Standard Error	Median
Region			
Northeast	1860.15	26.41	1769.5
North Central	1850.40	24.81	1819.0
South	1805.88	22.28	1712.0
West	1907.76	33.18	1819.0
Urbanization			
Central City	1846.23	25.59	1745.0
Suburban	1850.05	21.00	1788.0
Non-Metro	1871.86	23.87	1771.0
Income			
Under $5000	1894.00	44.85	1562.5
$5000-9,999	1903.04	38.66	1718.5
$10,000-14,999	1890.42	42.39	1787.0
$15,000-19,999	1962.89	67.91	1829.5
$20,000-24,999	1763.29	84.40	1812.0
$25,000 +	1825.28	84.63	1919.0
Not Reported	1753.41	38.18	1812.2
Household Size			
1 member	1896.05	90.54	1511.0
2 members	1835.58	32.78	1715.0
3-4 members	1865.03	21.67	1825.5
5 +	1827.53	25.81	1790.5
Race/Ethnicity			
White	1938.20	13.63	1787.0
Black	1846.40	41.02	1679.0
Spanish	1841.40	100.80	1715.5
Other	1798.18	111.07	1715.0
Employment Status			
Male Head			
Employed	1956.49[a]	37.93	1874.0
Not Employed	1789.95[b]	49.10	1634.0
Not Reported	1821.70[b]	171.28	1474.0
Female Head			
Employed	1724.69	21.26	1773.0
Not Employed	1735.93	17.19	1738.0
Not Reported	2107.52	185.86	2048.0
Education Level			
Male Head			
Elementary	1867.94	51.00	1694.0
High School	1843.68	40.00	1820.5
College	1881.50	42.96	1898.0
Not Reported	1831.07	171.93	1475.5
Female Head			
Elementary	1902.93	38.64	1590.0
High School	1970.42	18.11	1778.0
College	1940.70	37.18	1793.0
Not Reported	1610.13	167.98	1954.5

Within each factor, those values with different superscripts are significantly different at $p \leq 0.01$. Values are not different for factors without superscripts.

PROTEIN INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	42.05	0.42	41.3	0.9
North Central	41.88	0.39	40.2	1.3
South	41.48	0.35	40.9	1.5
West	41.53	0.52	41.2	0.7
Urbanization				
Central City	42.16	0.40	42.1	1.1
Suburban	42.00	0.33	40.5	1.2
Non-Metro	41.04	0.38	40.4	1.2
Income				
Under $5000	41.97	0.71	42.3	1.4
$5000-9,999	41.22	0.61	40.7	1.1
$10,000-14,999	40.95	0.67	40.5	0.9
$15,000-19,999	40.52	1.07	39.9	1.2
$20,000-24,999	43.41	1.33	40.4	1.2
$25,000 +	42.50	1.34	40.6	0.9
Not Reported	39.67	1.93	41.5	1.5
Household Size				
1 member	41.15	1.43	42.1	3.2
2 members	42.89	0.52	42.2	1.2
3-4 members	41.36	0.34	40.9	0.7
5 +	41.55	0.41	39.7	1.4
Race/Ethnicity				
White	40.21	0.22	40.5	1.2
Black	42.26	0.65	42.5	1.1
Spanish	41.42	1.59	43.2	0.0
Other	43.04	1.75	43.6	1.7
Employment Status				
Male Head				
Employed	43.04	0.60	40.1	1.0
Not Employed	43.42	0.78	42.2	1.3
Not Reported	38.75	2.71	42.5	1.7
Female Head				
Employed	41.92	0.34	40.6	1.0
Not Employed	42.12	0.27	40.9	1.2
Not Reported	41.16	2.94	41.1	2.8
Education Level				
Male Head				
Elementary	40.70	0.81	42.1	1.1
High School	39.92	0.63	39.9	1.2
College	40.48	0.68	40.6	1.0
Not Reported	45.84	2.72	42.5	1.6
Female Head				
Elementary	41.53	0.61	42.3	1.3
High School	41.43	0.29	40.6	1.0
College	41.34	0.43	40.5	1.4
Not Reported	42.65	2.65	41.3	2.4

FAT INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	44.76	0.33	45.0	20.5
North Central	45.28	0.31	45.7	17.1
South	44.61	0.28	44.4	22.9
West	45.81	0.42	45.5	17.0
Urbanization				
Central City	44.95	0.32	44.9	22.7
Suburban	45.64	0.26	45.5	17.6
Non-Metro	44.76	0.30	44.7	20.1
Income				
Under $5000	45.08	0.57	44.6	24.9
$5000-9,999	45.30	0.49	44.5	21.0
$10,000-14,999	44.11	0.53	44.7	20.8
$15,000-19,999	46.11	0.86	45.4	17.8
$20,000-24,999	44.21	1.06	45.7	19.0
$25,000 +	45.73	1.07	45.3	17.7
Not Reported	45.25	0.48	45.5	19.2
Household Size				
1 member	45.66[a]	1.14	44.8	25.1
2 members	45.94[a]	0.41	46.2	16.4
3-4 members	44.97[a]	0.27	45.5	17.8
5 +	43.89[b]	0.33	44.0	23.3
Race/Ethnicity				
White	46.39	0.17	45.3	18.6
Black	45.52	0.52	44.3	24.4
Spanish	42.62	1.27	40.2	40.6
Other	45.93	1.40	44.0	30.8
Employment Status				
Male Head				
Employed	47.71	0.48	50.1	18.7
Not Employed	47.32	0.62	50.9	19.9
Not Reported	40.31	2.16	49.5	24.8
Female Head				
Employed	45.35	0.27	45.3	18.4
Not Employed	44.64	0.22	44.7	21.0
Not Reported	45.37	2.34	46.4	15.1
Education Level				
Male Head				
Elementary	42.79	0.64	44.2	23.0
High School	43.54	0.50	45.4	17.6
College	43.57	0.54	45.0	19.0
Not Reported	50.56	2.17	44.7	24.5
Female Head				
Elementary	45.34	0.49	44.3	26.3
High School	45.37	0.23	45.2	18.3
College	44.75	0.34	44.8	20.4
Not Reported	44.99	2.12	45.6	15.0

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CARBOHYDRATE INTAKE PER 1000KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	104.99	0.94	104.5	93.2
North Central	105.45	0.88	107.0	93.6
South	107.81	0.79	108.4	91.2
West	105.37	1.18	104.3	93.7
Urbanization				
Central City	105.38	0.91	105.0	92.3
Suburban	104.51	0.75	105.3	93.1
Non-Metro	107.83	0.85	108.9	92.6
Income				
Under $5000	106.73	1.60	106.1	91.5
$5000-9,999	107.72	1.38	109.3	91.9
$10,000-14,999	108.77	1.51	108.4	92.7
$15,000-19,999	100.13	2.42	107.3	93.4
$20,000-24,999	108.26	3.01	106.3	93.3
$25,000 +	102.01	3.02	102.5	94.2
Not Reported	107.71	1.36	106.1	92.2
Household Size				
1 member	103.74[a]	3.23	104.4	88.8
2 members	103.16[a]	1.17	101.2	94.9
3-4 members	107.53[b]	0.77	105.3	93.7
5 +	109.20[b]	0.92	111.7	90.9
Race/Ethnicity				
White	104.43	0.49	106.3	93.0
Black	104.04	1.46	106.2	91.9
Spanish	110.39	3.59	116.4	91.4
Other	104.75	3.96	106.4	86.3
Employment Status				
Male Head				
Employed	97.73[a]	1.35	107.0	93.3
Not Employed	98.60[a]	1.75	106.1	93.4
Not Reported	121.38[b]	6.10	107.6	89.6
Female Head				
Employed	106.26	0.76	105.8	93.0
Not Employed	108.36	0.61	108.3	92.4
Not Reported	103.09	6.62	93.3	95.0
Education Level				
Male Head				
Elementary	112.88[a]	1.82	107.8	93.0
High School	112.15[a]	1.43	107.5	93.6
College	111.68[a]	1.53	106.3	92.9
Not Reported	86.90[b]	6.13	107.4	89.8
Female Head				
Elementary	106.31	1.38	107.5	90.8
High School	105.89	0.65	107.5	93.5
College	107.50	0.97	107.1	91.8
Not Reported	103.91	5.98	93.4	95.1

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CALCIUM INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	401.47[a]	6.82	378.0	64.7
North Central	405.79[a]	6.41	379.0	65.7
South	375.98[b]	5.76	337.0	76.0
West	415.49[a]	8.57	414.0	56.9
Urbanization				
Central City	400.58	6.61	363.0	69.8
Suburban	395.65	5.43	377.0	66.2
Non-Metro	402.82	6.17	362.0	67.6
Income				
Under $5000	405.63	11.59	369.0	67.9
$5000-9,999	406.77	9.99	361.5	68.7
$10,000-14,999	389.94	10.95	358.0	68.7
$15,000-19,999	379.31	17.54	368.5	66.3
$20,000-24,999	454.14	21.80	368.0	69.3
$25,000 +	365.12	21.86	389.5	65.0
Not Reported	396.88	9.86	362.0	67.9
Household Size				
1 member	437.41	23.39	377.0	65.1
2 members	385.34	8.47	333.0	75.3
3-4 members	391.36	5.60	365.0	67.9
5 +	384.62	6.67	387.0	63.2
Race/Ethnicity				
White	404.88[a]	3.52	373.0	66.1
Black	368.49[b]	10.60	330.0	79.6
Spanish	360.10[b]	26.04	344.0	68.0
Other	465.26[c]	28.69	378.0	65.8
Employment Status				
Male Head				
Employed	393.90	9.80	374.0	67.4
Not Employed	393.18	12.68	355.0	69.6
Not Reported	411.97	44.25	379.0	67.0
Female Head				
Employed	416.05[a]	5.49	364.0	68.0
Not Employed	436.01[a]	4.41	384.0	67.2
Not Reported	346.99[b]	48.01	295.0	73.2
Education Level				
Male Head				
Elementary	393.96	13.18	344.5	72.7
High School	396.78	10.33	351.5	70.3
College	424.56	11.10	410.0	62.3
Not Reported	383.43	44.42	377.5	66.9
Female Head				
Elementary	383.58	9.98	352.0	72.1
High School	387.42	4.68	364.0	69.7
College	414.69	7.02	403.0	61.4
Not Reported	413.03	43.39	324.5	72.8

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IRON INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	6.79	0.08	6.5	82.5
North Central	6.90	0.07	6.6	81.4
South	7.02	0.06	6.8	78.2
West	6.91	0.10	6.6	79.6
Urbanization				
Central City	6.99	0.07	6.8	77.2
Suburban	6.96	0.06	6.6	81.8
Non-Metro	6.76	0.07	6.6	80.9
Income				
Under $5000	7.02	0.13	6.9	76.7
$5000-9,999	7.04	0.11	6.8	76.1
$10,000-14,999	6.81	0.12	6.6	79.9
$15,000-19,999	6.44	0.19	6.5	85.8
$20,000-24,999	6.78	0.24	6.4	85.1
$25,000 +	7.11	0.24	6.5	81.3
Not Reported	7.14	0.11	6.6	78.2
Household Size				
1 member	6.72	0.26	7.1	73.3
2 members	7.18	0.09	7.0	72.6
3-4 members	6.85	0.06	6.5	82.3
5 +	6.87	0.07	6.5	84.0
Race/Ethnicity				
White	6.67	0.04	6.6	81.2
Black	6.75	0.12	6.9	76.4
Spanish	7.39	0.29	7.3	67.2
Other	6.81	0.32	7.2	70.1
Employment Status				
Male Head				
Employed	6.93	0.11	6.4	82.5
Not Employed	7.00	0.14	7.0	74.2
Not Reported	6.79	0.49	6.8	76.7
Female Head				
Employed	6.92	0.06	6.5	82.6
Not Employed	6.99	0.49	6.7	78.7
Not Reported	6.80	0.53	6.7	81.0
Education Level				
Male Head				
Elementary	6.99	0.15	7.0	72.8
High School	6.82	0.11	6.5	81.4
College	6.69	0.12	6.4	83.9
Not Reported	7.12	0.49	6.8	76.8
Female Head				
Elementary	7.06	0.11	7.2	69.5
High School	6.80	0.05	6.5	81.9
College	6.87	0.08	6.4	82.0
Not Reported	6.89	0.48	6.7	80.6

MAGNESIUM INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	136.42	1.56	132.0	69.7
North Central	137.22	1.46	130.0	70.8
South	132.88	1.31	124.0	75.0
West	139.66	1.96	138.0	62.2
Urbanization				
Central City	137.05	1.51	127.0	72.2
Suburban	137.16	1.24	132.0	69.0
Non-Metro	135.43	1.41	139.0	71.2
Income				
Under $5000	136.63	2.65	131.0	67.9
$5000-9,999	134.66	2.28	131.0	71.0
$10,000-14,999	135.93	2.50	127.0	71.8
$15,000-19,999	132.49	4.01	125.0	74.5
$20,000-24,999	147.40	4.98	127.0	74.3
$25,000 +	128.10	5.00	133.5	67.9
Not Reported	140.61	2.25	132.0	68.1
Household Size				
1 member	147.45	5.34	149.0	50.2
2 members	135.46	1.93	142.0	58.2
3-4 Members	131.46	1.28	128.0	73.1
5 +	131.81	1.52	123.0	79.4
Race/Ethnicity				
White	140.10[a]	0.80	132.0	68.3
Black	128.87[b]	2.42	116.0	85.9
Spanish	139.93[a]	5.95	120.5	89.8
Other	141.29[a]	6.55	132.0	66.7
Employment Status				
Male Head				
Employed	126.71[a]	2.24	125.0	73.6
Not Employed	134.04[b]	2.90	142.0	61.7
Not Reported	148.88[c]	10.11	131.0	67.1
Female Head				
Employed	135.25	1.25	126.0	72.2
Not Employed	137.56	1.01	132.0	69.7
Not Reported	136.83	10.97	125.0	69.8
Education Level				
Male Head				
Elementary	140.07	3.01	124.0	72.4
High School	142.23	2.36	126.0	73.4
College	144.19	2.54	135.0	67.8
Not Reported	119.69	10.15	130.5	67.6
Female Head				
Elementary	137.87	2.28	131.0	68.8
High School	137.63	1.07	127.0	74.2
College	143.86	1.60	136.0	64.8
Not Reported	126.83	9.91	124.5	70.9

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PHOSPHORUS INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	637.05	5.81	623.0	5.6
North Central	639.64	5.46	613.0	5.9
South	623.67	4.90	601.0	5.9
West	643.98	7.30	647.0	3.3
Urbanization				
Central City	640.17	5.63	618.0	5.3
Suburban	634.86	4.62	621.0	5.4
Non-Metro	633.23	5.25	612.0	5.5
Income				
Under $5000	644.12	9.87	629.5	4.8
$5000-9,999	639.21	8.50	607.5	6.4
$10,000-14,999	618.94	9.32	613.0	5.0
$15,000-19,999	628.11	14.94	606.5	5.7
$20,000-24,999	683.06	18.56	606.0	5.9
$25,000 +	608.22	18.62	627.0	5.1
Not Reported	630.96	8.40	621.0	5.0
Household Size				
1 member	663.50	19.91	636.5	6.6
2 members	642.56	7.21	619.0	5.1
3-4 members	623.38	4.77	619.0	5.3
5 +	614.90	5.68	610.0	5.5
Race/Ethnicity				
White	635.20	3.00	620.0	5.2
Black	608.77	9.02	595.0	7.1
Spanish	636.53	22.17	633.0	9.4
Other	663.85	24.43	638.0	1.7
Employment Status				
Male Head				
Employed	618.70	8.34	618.0	5.3
Not Employed	628.75	10.80	631.0	5.5
Not Reported	660.81	37.67	633.0	5.8
Female Head				
Employed	637.58	4.68	608.0	4.9
Not Employed	648.79	3.78	629.0	5.8
Not Reported	621.89	40.88	590.0	5.0
Education Level				
Male Head				
Elementary	643.77	11.22	613.0	4.9
High School	636.25	8.80	607.0	6.2
College	656.12	9.45	640.0	4.4
Not Reported	608.22	37.82	630.5	5.9
Female Head				
Elementary	631.10	8.50	617.0	5.2
High School	628.80	3.98	616.0	5.9
College	650.46	5.98	640.0	4.7
Not Reported	633.99	36.95	605.0	4.4

VITAMIN A INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	3132.46	161.20	2192.0	43.9
North Central	2850.37	151.43	2039.0	49.2
South	3158.11	135.98	2060.0	48.0
West	3202.62	202.50	2353.0	38.1
Urbanization				
Central City	3360.50	156.17	2352.0	40.8
Suburban	3145.86	128.18	2137.0	45.0
Non-Metro	2751.31	145.68	1993.0	50.2
Income				
Under $5000	3181.45	373.73	2316.0	43.2
$5000-9,999	3116.16	235.91	2168.0	44.7
$10,000-14,999	2975.64	258.68	2079.5	47.6
$15,000-19,999	2470.60	414.47	1952.0	52.2
$20,000-24,999	3258.20	515.07	2152.0	42.9
$25,000 +	3390.85	516.50	2186.5	43.5
Not Reported	3208.34	232.98	2122.0	45.2
Household Size				
1 member	3688.35	552.56	2806.5	30.8
2 members	3292.25	200.03	2452.0	37.7
3-4 members	2841.49	132.24	2040.0	48.9
5 +	2521.47	157.54	1991.0	50.3
Race/Ethnicity				
White	2781.82[a]	83.20	2121.0	46.0
Black	3573.10[b]	250.34	2329.0	41.9
Spanish	1900.52[c]	615.17	1589.5	67.2
Other	4088.13[b]	677.83	2421.0	43.6
Employment Status				
Male Head				
Employed	3456.90	231.48	2084.0	48.1
Not Employed	3007.04	299.67	2300.0	39.1
Not Reported	2793.73	1045.28	2329.0	42.9
Female Head				
Employed	3190.31	129.73	2136.0	48.6
Not Employed	3352.23	104.92	2188.0	43.9
Not Reported	2715.13	1134.26	1812.0	48.6
Education Level				
Male Head				
Elementary	3491.91	311.27	2064.5	48.3
High School	3009.89	244.11	2079.5	48.9
College	2776.27	262.20	2207.0	42.3
Not Reported	3065.49	1049.30	2330.0	42.9
Female Head				
Elementary	3166.39	235.83	2159.0	48.5
High School	3225.20	110.51	2075.0	48.7
College	3529.53	165.90	2322.0	39.1
Not Reported	2422.44	1025.16	1685.0	48.5

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THIAMIN INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	0.69	0.01	0.66	15.9
North Central	0.70	0.01	0.66	14.6
South	0.70	0.01	0.68	12.7
West	0.68	0.01	0.63	17.4
Urbanization				
Central City	0.70	0.01	0.67	14.1
Suburban	0.70	0.01	0.65	15.8
Non-Metro	0.68	0.01	0.67	13.9
Income				
Under $5000	0.70	0.02	0.70	10.5
$5000-9,999	0.71	0.01	0.67	13.1
$10,000-14,999	0.68	0.01	0.67	12.7
$15,000-19,999	0.66	0.02	0.66	13.8
$20,000-24,999	0.71	0.03	0.61	20.2
$25,000 +	0.68	0.03	0.63	16.7
Not Reported	0.71	0.01	0.66	16.0
Household Size				
1 member	0.69	0.03	0.66	15.5
2 members	0.70	0.01	0.66	16.7
3-4 members	0.69	0.01	0.65	15.6
5 +	0.70	0.01	0.67	12.3
Race/Ethnicity				
White	0.64^{a}	0.00	0.65	15.3
Black	0.69^{b}	0.01	0.71	11.7
Spanish	0.74^{c}	0.03	0.78	10.9
Other	0.70^{b}	0.04	0.71	7.7
Employment Status				
Male Head				
Employed	0.67	0.01	0.65	16.1
Not Employed	0.67	0.02	0.68	12.2
Not Reported	0.74	0.06	0.68	11.1
Female Head				
Employed	0.67	0.07	0.65	16.8
Not Employed	0.69	0.01	0.67	13.1
Not Reported	0.72	0.06	0.61	17.3
Education Level				
Male Head				
Elementary	0.71	0.02	0.68	10.5
High School	0.70	0.01	0.65	16.6
College	0.71	0.01	0.64	15.7
Not Reported	0.66	0.06	0.68	11.3
Female Head				
Elementary	0.71	0.01	0.70	11.1
High School	0.70	0.06	0.66	15.1
College	0.71	0.01	0.65	15.3
Not Reported	0.65	0.06	0.61	17.0

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RIBOFLAVIN INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	0.95	0.02	0.87	8.7
North Central	0.96	0.01	0.89	7.5
South	0.93	0.01	0.84	9.6
West	0.95	0.02	0.89	7.7
Urbanization				
Central City	0.97	0.02	0.86	9.0
Suburban	0.95	0.01	0.87	8.6
Non-Metro	0.93	0.01	0.87	8.2
Income				
Under $5000	0.97	0.03	0.90	8.0
$5000-9,999	0.97	0.02	0.86	8.2
$10,000-14,999	0.92	0.03	0.88	8.0
$15,000-19,999	0.90	0.04	0.86	9.3
$20,000-24,999	1.01	0.05	0.84	9.8
$25,000 +	0.92	0.05	0.88	7.9
Not Reported	0.96	0.02	0.86	8.7
Household Size				
1 member	1.00	0.05	0.88	8.0
2 members	0.97	0.02	0.84	8.1
3-4 members	0.91	0.01	0.86	9.6
5 +	0.91	0.02	0.90	7.8
Race/Ethnicity				
White	0.94	0.01	0.87	8.8
Black	0.94	0.02	0.84	10.5
Spanish	0.91	0.06	0.88	13.3
Other	1.01	0.07	0.87	10.3
Employment Status				
Male Head				
Employed	0.93	0.02	0.88	9.1
Not Employed	0.91	0.03	0.87	7.9
Not Reported	1.01	0.10	0.90	6.8
Female Head				
Employed	0.96	0.01	0.86	8.7
Not Employed	0.99	0.01	0.90	8.4
Not Reported	0.90	0.11	0.83	10.1
Education Level				
Male Head				
Elementary	0.99	0.03	0.87	7.9
High School	0.95	0.02	0.85	10.3
College	0.98	0.03	0.90	7.4
Not Reported	0.87	0.10	0.90	6.9
Female Head				
Elementary	0.94	0.02	0.88	9.0
High School	0.95	0.01	0.87	9.1
College	0.98	0.02	0.90	7.2
Not Reported	0.92	1.00	0.83	10.2

NIACIN INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	10.40	0.13	9.9	8.9
North Central	10.30	0.13	9.7	10.1
South	10.54	0.11	10.0	7.8
West	10.17	0.17	9.7	11.2
Urbanization				
Central City	10.62[a]	0.13	10.2	8.5
Suburban	10.45[a]	0.11	9.9	9.0
Non-Metro	9.99[b]	0.12	9.7	9.8
Income				
Under $5000	10.44	0.23	10.2	9.4
$5000-9,999	10.11	0.20	9.7	9.5
$10,000-14,999	10.21	0.22	10.0	8.7
$15,000-19,999	10.12	0.35	9.7	10.3
$20,000-24,999	10.59	0.43	9.8	8.5
$25,000 +	10.55	0.43	9.9	8.6
Not Reported	10.44	0.19	9.9	9.3
Household Size				
1 member	10.42	0.46	10.2	13.7
2 members	10.61	0.17	10.3	7.0
3-4 members	10.10	0.11	9.8	9.2
5 +	10.28	0.13	9.6	9.8
Race/Ethnicity				
White	10.21	0.07	9.8	9.6
Black	10.39	0.21	10.1	6.8
Spanish	10.53	0.51	10.6	3.9
Other	10.28	0.56	10.5	8.5
Employment Status				
Male Head				
Employed	10.21	0.19	9.7	9.5
Not Employed	10.34	0.25	10.2	6.5
Not Reported	10.5	0.87	10.1	11.0
Female Head				
Employed	10.37	0.11	9.8	9.8
Not Employed	10.25	0.09	9.9	8.8
Not Reported	10.43	0.94	10.0	9.5
Education Level				
Male Head				
Elementary	10.57	0.26	10.1	5.9
High School	10.25	0.20	9.7	8.9
College	10.23	0.22	9.8	10.1
Not Reported	10.35	0.87	10.1	11.0
Female Head				
Elementary	10.29	0.20	10.0	7.1
High School	10.39	0.09	9.8	9.0
College	10.42	0.14	9.9	10.7
Not Reported	10.31	0.85	10.0	8.3

Within each factor, those values with different superscripts are significantly different at $p \leq 0.01$. Values are not different for factors without superscripts.

VITAMIN B-6 INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	0.80	0.01	0.76	82.9
North Central	0.78	0.01	0.75	85.2
South	0.79	0.01	0.74	83.2
West	0.78	0.01	0.76	81.7
Urbanization				
Central City	0.81[a]	0.01	0.78	80.2
Suburban	0.79[a]	0.01	0.75	83.3
Non-Metro	0.75[b]	0.01	0.73	85.8
Income				
Under $5000	0.77	0.02	0.76	80.4
$5000-9,999	0.78	0.02	0.75	83.0
$10,000-14,999	0.76	0.02	0.74	84.9
$15,000-19,999	0.77	0.03	0.72	86.4
$20,000-24,999	0.83	0.04	0.76	82.9
$25,000 +	0.80	0.04	0.76	83.8
Not Reported	0.80	0.02	0.75	81.9
Household Size				
1 member	0.83[a]	0.04	0.80	77.9
2 members	0.82[a]	0.01	0.80	74.5
3-4 members	0.76[b]	0.01	0.74	84.5
5 +	0.73[b]	0.01	0.72	88.9
Race/Ethnicity				
White	0.77	0.01	0.75	83.6
Black	0.79	0.02	0.76	82.8
Spanish	0.83	0.04	0.80	84.4
Other	0.75	0.05	0.80	78.6
Employment Status				
Male Head				
Employed	0.78	0.02	0.74	85.0
Not Employed	0.78	0.02	0.77	79.2
Not Reported	0.79	0.07	0.76	81.0
Female Head				
Employed	0.78	0.01	0.75	83.5
Not Employed	0.78	0.01	0.75	83.2
Not Reported	0.79	0.08	0.71	87.7
Education Level				
Male Head				
Elementary	0.80	0.02	0.77	82.8
High School	0.78	0.02	0.74	84.6
College	0.79	0.02	0.75	83.7
Not Reported	0.77	0.07	0.76	80.7
Female Head				
Elementary	0.79	0.02	0.74	82.0
High School	0.81	0.01	0.75	84.6
College	0.82	0.01	0.76	81.6
Not Reported	0.73	0.07	0.70	86.4

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VITAMIN B-12 INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	3.17	0.22	2.14	18.1
North Central	2.83	0.21	2.10	18.9
South	2.81	0.19	1.90	28.6
West	2.98	0.28	2.20	16.7
Urbanization				
Central City	3.15	0.21	2.05	22.3
Suburban	3.09	0.17	2.10	20.1
Non-Metro	2.60	0.20	2.01	23.0
Income				
Under $5000	3.46	0.37	1.98	22.7
$5000-9,999	2.97	0.32	1.97	25.2
$10,000-14,999	2.91	0.35	2.09	22.3
$15,000-19,999	2.60	0.56	2.02	21.4
$20,000-24,999	2.43	0.70	2.04	20.1
$25,000 +	3.35	0.70	2.24	16.7
Not Reported	2.91	0.32	2.06	22.8
Household Size				
1 member	2.97	0.75	2.05	24.7
2 members	3.57	0.27	2.06	24.0
3-4 members	2.73	0.18	2.07	21.1
5 +	2.52	0.21	2.04	20.6
Race/Ethnicity				
White	2.87	0.11	2.07	21.2
Black	3.26	0.34	1.90	27.0
Spanish	2.30	0.84	2.09	18.0
Other	3.36	0.92	2.20	15.4
Employment Status				
Male Head				
Employed	3.25	0.32	2.06	20.3
Not Employed	2.67	0.41	2.19	25.4
Not Reported	2.93	1.42	2.00	24.4
Female Head				
Employed	3.01	0.18	2.08	20.7
Not Employed	3.20	0.14	2.06	22.5
Not Reported	2.64	1.54	2.04	19.6
Education Level				
Male Head				
Elementary	3.51	0.42	2.04	24.4
High School	2.94	0.33	2.06	21.9
College	2.58	0.36	2.17	19.2
Not Reported	2.76	1.43	2.00	24.1
Female Head				
Elementary	2.97	0.32	1.97	26.2
High School	3.03	0.15	2.07	21.7
College	3.20	0.23	2.13	20.1
Not Reported	2.59	1.40	2.04	18.9

VITAMIN C INTAKE PER 1000 KCAL

Variable	Adjusted Mean	Standard Error	Median	% Below Standard
Region				
Northeast	52.39[a]	1.52	45.0	30.1
North Central	45.60[b]	1.43	37.0	39.0
South	44.98[b]	1.28	35.0	41.2
West	47.63[b]	1.91	44.0	32.4
Urbanization				
Central City	48.93[a]	1.47	42.0	32.9
Suburban	49.80[a]	1.21	40.0	34.4
Non-Metro	44.22[b]	1.38	35.0	41.6
Income				
Under $5000	42.02	2.58	39.0	38.4
$5000-9,999	49.61	2.22	38.0	36.5
$10,000-14,999	52.87	2.44	37.0	38.9
$15,000-19,999	41.40	3.91	36.0	39.6
$20,000-24,999	49.96	4.86	40.0	35.6
$25,000 +	47.40	4.88	43.8	32.7
Not Reported	50.30	2.20	38.0	35.7
Household Size				
1 member	56.77[a]	5.22	52.0	28.8
2 members	48.52[b]	1.89	45.0	30.3
3-4 members	44.24[b]	1.25	37.0	37.3
5 +	41.08[c]	1.49	35.0	41.5
Race/Ethnicity				
White	45.42	0.79	38.0	37.3
Black	53.56	2.36	43.0	33.3
Spanish	46.13	5.81	37.0	35.9
Other	45.50	6.40	41.0	34.2
Employment Status				
Male Head				
Employed	43.78	2.19	37.0	38.1
Not Employed	44.36	2.83	41.0	33.2
Not Reported	54.81	9.87	42.0	34.7
Female Head				
Employed	49.98	1.23	37.0	39.3
Not Employed	51.26	0.99	39.0	34.8
Not Reported	41.71	10.71	25.0	43.0
Education Level				
Male Head				
Elementary	50.11	2.94	34.0	43.0
High School	48.34	2.31	34.0	40.2
College	54.00	2.48	43.0	30.2
Not Reported	38.16	9.91	41.0	35.2
Female Head				
Elementary	45.34[a]	2.23	35.0	40.7
High School	50.88[b]	1.04	36.0	39.8
College	54.74[b]	1.57	44.0	28.5
Not Reported	39.65[c]	9.68	26.0	43.2

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Refereed Publications

Windham, C.T., Wyse, B.W., Hurst, R.L. and Hansen, R.G. Consistency of Nutrition Consumption Patterns in the United

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Invited Presentations

Going Back is Going Forward. Utah State University. Women's Center Conversations. May 1981. Logan, Utah.